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Heating · Piping and Air Conditioning

Selection of Pipe Bends Simplified

By W. G. Hooper*

EVOLUTION of steam pressures and temperatures in the past three decades has necessitated equally radical revisions in deflection values and the resultant formulas for the calculation of various types of pipe bends. Due to higher pressures and temperatures it has become necessary to compensate for greatly increased expansion in piping systems.

From a study of the progress in design and manufacture of piping equipment, it appears that 200 lb. W.S.P. was considered "high pressure" up to about 1914; this was increased to 600 lb. by 1923. In 1925 a 1,200-lb. boiler was placed in service and today there are a few 1,800 lb. installations. (See Fig. 1.)

A chronological study of the increase in steam temperature is interesting. It shows that until 1907 no superheaters were in use and that from the advent of superheaters to the present time, the temperature has increased from 500 to 1,000 F.

Flattening of the Cross-Section

About 1928, the theory of the flattening of the circular cross-section in the curved portion of a bend was proposed. It evidently met the approval of a majority of investigators, as since then many authorities have developed formulas that are essentially alike. The results in-

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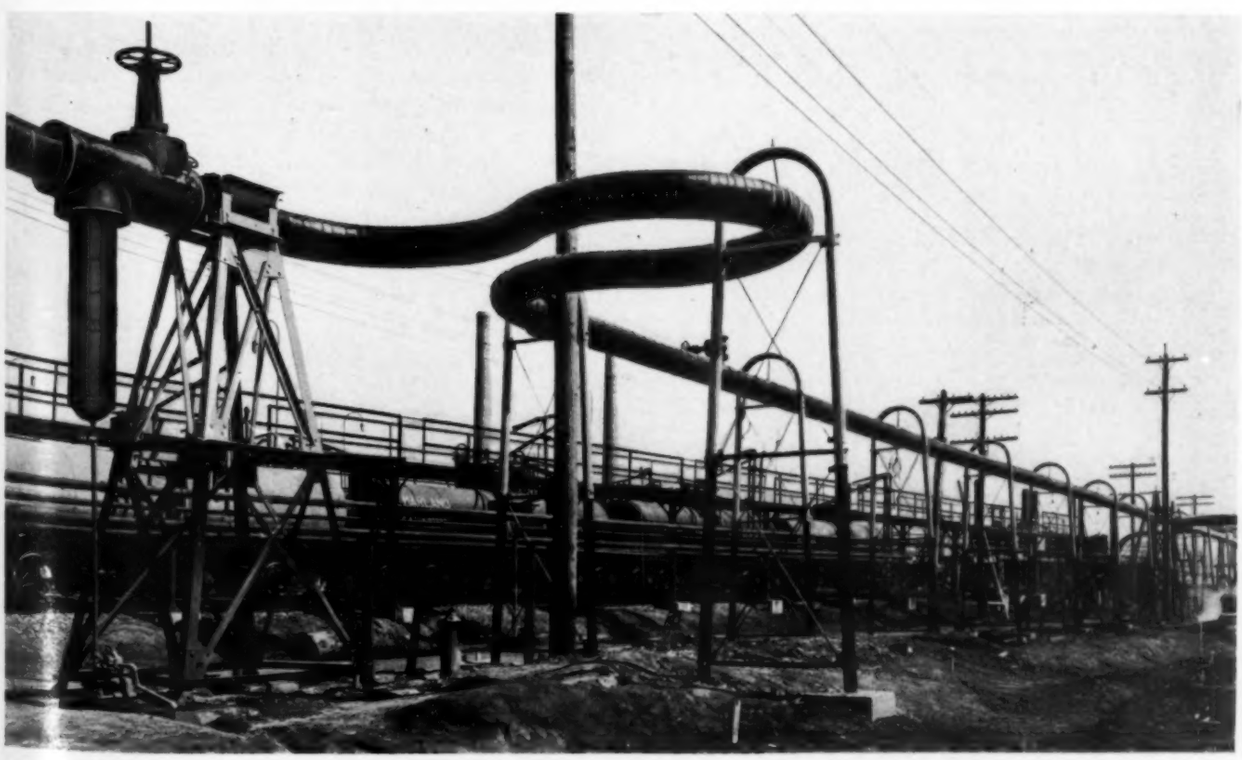
Double-offset expansion U-bend in a high-pressure line



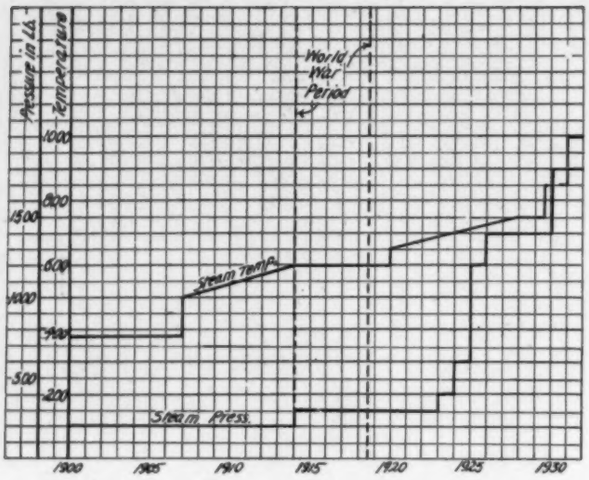


Fig. 1—Evolution in steam pressures and temperatures

SYMBOLS

Δ = Deflection in in.
F = Generalized force causing deflection in lb.
E = Modulus of elasticity at working temperature.
S = Allowable fibre stress at working temperature.
I = Moment of inertia = 0.049 (D^4-d^4).

K = Flexibility multiplication factor = $\dfrac{12h^2+10}{12h^2+1}$.

β = Longitudinal stress mult. factor $\dfrac{2K}{3}\sqrt{\dfrac{6h^2+5}{18}}$

h = Pipe bend ratio = $\dfrac{tR}{r^2}$

D = Outside diameter of pipe in in.
d = Inside diameter of pipe in in.

r = Mean radius of pipe cross-section in inches = $\dfrac{D-t}{2}$

t = Wall thickness of pipe in in.
R = Radius of bend in in.
M = Maximum bending moment in in.-lb.
P = Internal working pressure lb. per sq. in.

BASIC FORMULAS

$$\Delta = \frac{\text{Constant} \times R^3 K F}{EI}$$

$$S = \frac{\beta M r}{I}, \quad M = \frac{SI}{\beta r}$$

$M = F \times L$ (distance from Axis to point of Max. Bending Moment)

L
90° Bend = $1R$
180° Bend = $2R$
Exp. U. Bend = $2R$
Dbl. Off. Exp. Bend = $(2+\sqrt{2})$ R or 3.414 R.

Longitudinal Stress due to Working Pressure.

$$S_L = \frac{Pd}{4t}$$

Transverse Stress due to Working Pressure.

$$S_T = \frac{Pd}{2t}$$

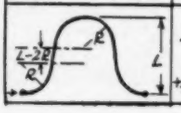
Type of Bend	Deflection = Δ Inches	Force = F lb.	Stress = S	Moment = M
	$\Delta = \dfrac{0.356\,R^3KS}{E\beta r}$	$F = \dfrac{\Delta EI}{0.356\,R^3K}$	$S = \dfrac{\beta Mr}{I}$	$M = F \times L$
	$\Delta = \dfrac{2.35\,R^3KS}{E\beta r}$	$F = \dfrac{\Delta EI}{4.71\,R^3K}$	$S = \dfrac{\beta Mr}{I}$	$M = F \times L$
	$\Delta = \dfrac{4.71\,R^3KS}{E\beta r}$	$F = \dfrac{\Delta EI}{9.42\,R^3K}$	$S = \dfrac{\beta Mr}{I}$	$M = F \times L$
	$\Delta = \dfrac{11.68\,R^3KS}{E\beta r}$	$F = \dfrac{\Delta EI}{39.88\,R^3K}$	$S = \dfrac{\beta Mr}{I}$	$M = F \times L$
	$\Delta = \dfrac{S}{E\beta r}\{RK[\pi(L^2+2RL+3R^2)+(4RL-8R^2)]+\frac{2}{3}[L^3+3RL^2+3R^2L-2R^3]\}$	$F = \dfrac{\Delta EI}{\{RK[\pi(L^2+2RL+3R^2)+(4RL-8R^2)]+\frac{2}{3}[L^3+3RL^2+3R^2L-2R^3]\}}$	$S = \dfrac{\beta Mr}{I}$	$M = F \times L$

Fig. 2—Bending formulas for five types of bends

dicate that the flattening of the curved portion during flexure should be given consideration. It may be of interest to know, however, that this flattening theory was discussed by foreign mathematicians as early as 1910.

The flattening theory has been responsible for considerable change in former formulas derived from investigations on curved bars. Allowable deflection in bends was supposedly unaffected by different pipe-wall thicknesses, according to these formulas; in other words, the expansion value of bends of like type, nominal pipe size and bending radius was identical regardless of differences in pipe-wall thickness.

If expansion values are compared for the quarter bend, U-bend, expansion U-bend and double offset expansion U-bend, the formulas presented in this article show a ratio of 1:6.6:13.2:32.8, the value for the quarter bend being taken as unity. The actual solved values of deflection are appreciably affected by the factor of flexibility and the longitudinal stress multiplication factor; it will be noted that the values of deflection for the expansion U and double offset expansion bends are considerably increased. It is also evident that the variation of wall thickness affects the deflection to an appreciable degree.

The formulas given here (Fig. 2) for these five types of expansion bends are by no means original but are presented as being formulas which in the writer's opinion will give satisfactory results.

Assumptions Made in Formulas

In the equations it is assumed that one end of the quarter bend and U-bend is fixed while the other end is free; these two types of bends are used chiefly in connections to apparatus; the quarter bend also for changing direction of flow. The expansion U-bend, double offset expansion bend and the modified expansion U-bend are used to compensate for expansion in pipe lines due to temperature change and are treated in the formulas as though both ends were free.

Comparison With Other Formulas

It will be noted that the formulas given in Fig. 2 are similar to those presented by Crocker and Sanford about

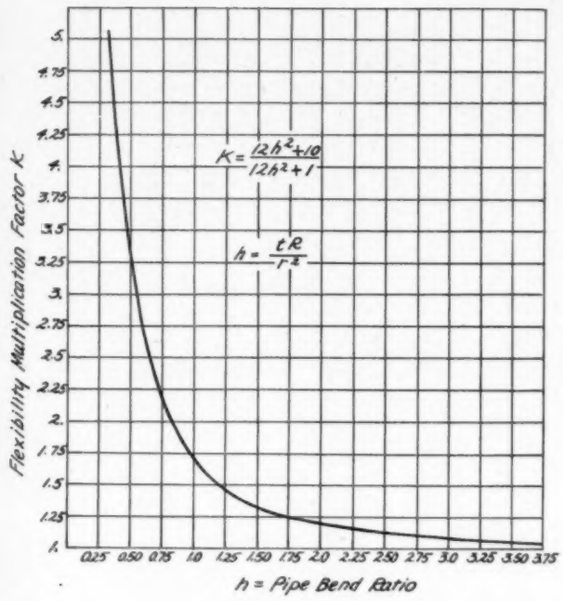


Fig. 3—Curve for determining flexibility multiplication factor K for curved pipe

Increase in steam pressures and temperatures during the past few years has made it necessary to compensate for increased expansion in piping systems. This article is based on the work of several investigators and on a wide experience in piping design.

The data presented here are planned to be sufficiently comprehensive to enable the piping designer to complete his calculations without recourse to numerous handbooks and without going through voluminous mathematical calculations. A typical example, with references to the figures and tables, shows how the data are used.

1922, with the exception of the addition of factors K and β. A comprehensive explanation of these two factors would require the presentation of virtually all the calculations and data given by numerous authorities over a period of two decades, and would make this article entirely too long. However, these calculations together with results of tests made by Hovgaard have been published by the *Massachusetts Institute of Technology;* they cover the theory thoroughly.

Crocker in his article, "Bending of Curved Pipes," in the May, 1931, HEATING, PIPING AND AIR CONDITIONING and Chapter VII (entitled "Expansion and Flexibility") of the *Piping Hand Book,* gives a clear and extremely concise explanation of the flattening theory.

Attention should be called to the fact that in Crocker's article, K is termed the rigidity multiplication factor, and is the reciprocal of K as used in these formulas and shown in Fig. 3, where it is the flexibility multiplication factor. His formula for β, the longitudinal stress multiplication factor, places K in the denominator rather than in the numerator as given in Fig. 4.

The pipe bend ratio h (which is a function of both K and β) is the pipe-wall thickness divided by the square of the mean pipe cross-sectional radius and multiplied by the bending radius. Tables 1 to 6 give the factor t/r^2 for the various pipe-wall thicknesses; this factor is simply multiplied by the predetermined bend radius in inches to obtain h which is necessary in solving for K and β. Figs. 3 and 4 give values for K and β respectively, h being the abscissae.

The term F used in these formulas is to be considered as that force or thrust in pounds necessary to obtain the stipulated amount of deflection in the selected bend.

The examples presented here cover the general requirements of the expansion bends that are usually embodied in a piping lay-out. All of these formulas must be used with judgment, as there is probably nothing so dangerous to safe design as the blind use of empirical formulas. Naturally, there will be instances where they may not apply and such cases require special treatment. The designer's attention is particularly called to the fact that much study and care should be given to the proper method of supporting and anchoring so that flexibility is obtained throughout the piping lay-out.

Curves Shown Here Simplify Calculation

In the preparation of this paper, considerable time and effort were expended to make the data sufficiently comprehensive for the piping designer to complete his calculations without recourse to numerous handbooks and without wading through voluminous calculations.

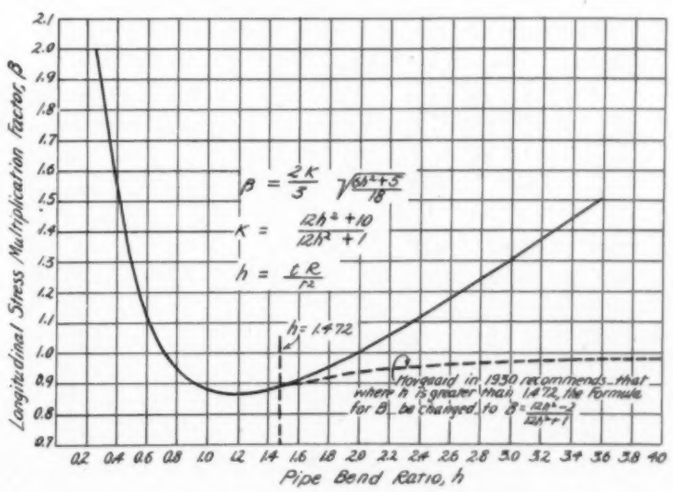

Longitudinal Stress Multiplication Factor, β
$\beta = \frac{2K}{3}\sqrt{\frac{6h^2+3}{18}}$
$K = \frac{12h^2+10}{12h^2+1}$
$h = \frac{tR}{r^2}$
h = 1.472
Hovgaard in 1930 recommends that where h is greater than 1.472, the formula for β be changed to $\beta = \frac{12h^2-2}{12h^2+1}$
Pipe Bend Ratio, h

Fig. 4—Curve for determining longitudinal stress multiplication factor β for curved pipe

The information contained in this paper is a composite assembly of the investigations made by the following authorities on this subject:

Crocker & Sanford, *Mechanical Engineering*.....1922
Wm. Hovgaard, *Journal of Mathematics & Physics*..1926-28-29
A. M. Wall, *A. S. M. E. Transactions*.....1928
W. H. Shipman, *A. S. M. E. Transactions*.....1929
Walker & Crocker, *Piping Hand Book*.....2nd Edition

Crediting Deflection by Amount of Cold Spring

A number of investigators recommend that no allowance be made for the amount of cold springing that is given to a bend at erection. However, many engineers approve the practice of crediting the required deflection due to expansion with the amount of cold spring; in other words, if the line is cut short one-half the total expansion due to temperature and the bend cold sprung that amount in erection, the deflection on which calculations are based will be one-half the total expansion. The stresses will be reduced in proportion to the amount of cold springing.

It will be noted in Fig. 4 that when h is greater than 1.472, two values can be assigned to β (the longitudinal stress multiplication factor). The curve shown dotted gives values recommended by Hovgaard. However, all other investigators make no mention of any change in the formula for β for values of h above 1.472.

These are but a few of the points on which the designer must use his best judgment.

Solution of a Typical Problem

Required: To check the suitability of a 10-in. double offset expansion U-bend to compensate for the linear expansion of 50 ft. of pipe.

Working conditions: 600 lb. W.S.P. and 750 F total temperature.

Radius of Bend (R) = 60 in.

Calculations

According to Fig. 5, the linear expansion of 100 ft.

Table 1—Standard Pipe

Nominal Size	Outside Diameter D	Wall Thickness t	Mean Radius r	Factor $\frac{t}{r^2}$	Moment Inertia I
2½	2.875	0.203	1.336	0.114	1.530
3	3.50	0.216	1.642	0.0801	2.017
3½	4.00	0.226	1.887	0.0634	4.788
4	4.50	0.237	2.131	0.0522	7.233
5	5.563	0.258	2.653	0.0367	15.160
6	6.625	0.280	3.173	0.02785	28.140
8—28#	8.625	0.322	4.152	0.0187	72.49
10—41#	10.750	0.365	5.193	0.01354	160.70
12—50#	12.750	0.375	6.188	0.0097	279.30
14	14	0.375	6.813	0.00808	372.80
16	16	0.375	7.813	0.00615	562.10
18	18	0.375	8.813	0.00484	806.60
20	20	0.375	9.813	0.0039	1113.00
24	24	0.375	11.813	0.0027	1942.00

h = Factor $\frac{t}{r^2}$ x R (Mean Radius of Bend, Inches)

Table 2—Extra-Strong Pipe

Nominal Size	Outside Diameter D	Wall Thickness t	Mean Radius r	Factor $\frac{t}{r^2}$	Moment Inertia I
2½	2.875	0.276	1.30	0.1636	1.924
3	3.50	0.300	1.60	0.1172	3.894
3½	4.00	0.318	1.841	0.0938	6.280
4	4.50	0.337	2.082	0.0778	9.610
5	5.563	0.375	2.594	0.0557	20.670
6	6.625	0.432	3.097	0.0451	40.490
8	8.625	0.50	4.063	0.0302	105.70
10	10.75	0.50	5.13	0.0190	212.00
12	12.75	0.50	6.13	0.0133	361.50
14	14.0	0.50	6.75	0.0110	483.80
16	16	0.50	7.75	0.0083	731.90
18	18	0.50	8.75	0.0064	1053.00
20	20	0.50	9.75	0.0052	1457.00
24	24	0.50	11.75	0.0036	2549.00

Table 3—400-Lb. (ASA Std.) Seamless Pipe

Nominal Size	Outside Diameter D	Wall Thickness t	Mean Radius r	Factor $\frac{t}{r^2}$	Moment Inertia I
2½	2.875	0.203	1.336	0.1137	1.530
3	3.50	0.216	1.642	0.0801	3.017
3½	4.00	0.226	1.887	0.0634	4.788
4	4.50	0.237	2.132	0.0522	7.233
5	5.563	0.258	2.653	0.0367	15.160
6	6.625	0.288	3.168	0.0287	28.84
8	8.625	0.344	4.140	0.0200	76.80
10	10.75	0.395	5.178	0.0147	172.50
12	12.75	0.50	6.125	0.0133	361.50
14	14	0.50	6.75	0.0109	483.80
16	16	0.531	7.735	0.0089	771.10
18	18	0.594	8.703	0.0078	1230.50
20	20	0.625	9.688	0.0067	1787.00
24	24	0.750	11.625	0.0055	3705.00

Table 4—600-Lb. (ASA Std.) Seamless Pipe

Nominal Size	Outside Diameter D	Wall Thickness t	Mean Radius r	Factor $\frac{t}{r^2}$	Moment Inertia I
2½	2.875	0.217	1.329	0.1228	1.611
3	3.50	0.241	1.630	0.0912	3.294
3½	4.00	0.281	1.860	0.0812	5.708
4	4.50	0.281	2.110	0.0632	8.308
5	5.563	0.352	2.606	0.0519	19.650
6	6.625	0.385	3.120	0.0396	36.870
8	8.625	0.469	4.078	0.0282	99.809
10	10.75	0.531	5.11	0.0203	375.20
12	12.75	0.625	6.063	0.0170	438.70
14	14	0.656	6.672	0.0147	612.50
16	16	0.750	7.625	0.0129	1047.00
18	18	0.8125	8.594	0.0110	1620.77
20	20	0.906	9.548	0.0099	2477.93
24	24	1.031	11.485	0.0078	4907.35

of pipe at 750 F is 6.1 in. or 3.05 in. for 50 ft.; this is the deflection (Δ) that the bend must care for.

Table 5—900-Lb. (ASA Std.) Seamless Pipe

Nominal Size	Outside Diameter D	Wall Thickness t	Mean Radius r	Factor $\frac{t}{r^2}$	Moment Inertia I
2½	2.875	0.276	1.30	0.1636	1.924
3	3.50	0.3125	1.594	0.1230	4.006
3½	4.00	0.344	1.828	0.1029	6.633
4	4.50	0.375	2.063	0.0882	10.40
5	5.563	0.437	2.563	0.0665	23.239
6	6.625	0.50	3.063	0.0533	45.338
8	8.625	0.625	4.00	0.0391	126.199
10	10.75	0.750	5.00	0.0300	296.20
12	12.75	0.875	5.938	0.0248	578.50
14	14	0.9375	6.531	0.0219	823.12
16	16	1.031	7.485	0.0184	1362.01
18	18	1.156	8.422	0.0163	2175.81
20	20	1.281	9.360	0.0146	3309.12
24	24	1.50	11.250	0.0118	6727.45

Table 6—1500-Lb. (ASA Std.) Seamless Pipe

Nominal Size	Outside Diameter D	Wall Thickness t	Mean Radius r	Factor $\frac{t}{r^2}$	Moment Inertia I
2½	2.875	0.375	1.250	0.2400	2.3527
3	3.50	0.406	1.547	0.1696	4.809
3½	4.00	0.469	1.766	0.1504	8.2256
4	4.50	0.50	2.00	0.1250	12.763
5	5.563	0.625	2.469	0.1025	29.972
6	6.625	0.687	2.969	0.0779	57.152
8	8.625	0.875	3.875	0.0582	161.696
10	10.75	1.06	4.845	0.0451	383.262
12	12.75	1.219	5.766	0.0367	740.831
14	14	1.344	6.328	0.0336	1080.357
16	16	1.50	7.250	0.0285	1811.775

Δ (Deflection)	$= 3.05$ in.	
E (Mod. Elas. at 750°)	$= 24.75 \times 10^6$	Ref. Fig. 6
h (Pipe Bend Ratio)	$= 0.0203 \times 60'' = 1.218$	Ref. Table 4
K (Flex. Factor)	$= 1.5$	Ref. Fig. 3
β (Long. Stress Factor)	$= 0.87$	Ref. Fig. 4
I (Mom. Inertia)	$= 375.2$	Ref. Table 4
R (Radius of Bend)	$= 60$ in.	
r (mean radius cross section)	$= 5.11$ in.	Ref. Table 4

Formula for double offset expansion U-bend — Ref. Fig. 2

$$\Delta = \frac{11.68\ R^2\ KS}{E\ \beta\ r}$$

Substituting values, $3.05 = \dfrac{11.68 \times 60 \times 60 \times 1.5 \times S}{24.75 \times 10^6 \times 0.87 \times 5.11}$

$S = 5320$ lb. per sq. in. fibre stress

Refer to stress curve (Fig. 6) and it will be found that the recommended stress is 10,500 lb. per sq. in. Therefore this bend could be subjected to double the required expansion and still be within safe limits. If cold springing is considered then this bend might safely handle four times the expansion, or approximately 12 in.

The next step is to calculate the thrust. Substituting the known values in the force formula in Fig. 2, we have:

$$F = \frac{\Delta\ E\ I}{39.88\ R^2\ K}$$

$$F = \frac{3.05 \times 24.75 \times 10^6 \times 375.2}{39.88 \times 60 \times 60 \times 60 \times 1.5}$$

$F = 2192$ lb.

To determine the moment:

M (Moment) $= F \times L$

M (Moment) $= 2192 \times (3.414 \times 60)$

M (Moment) $= 449{,}000$ in.-lb.

If for this particular case an expansion U-bend is considered instead of the double offset expansion U-bend and cold springing is used to the amount of one-half of the calculated expansion, the expansion U-bend will be subjected to a bending fibre stress of 6,597 lb. and a thrust of 4,640 lb. These stress and thrust values will, of course, be doubled if cold springing is not considered.

If the radius R of the double offset expansion U-bend is 50 in. instead of 60 in. the stress will be increased to approximately 6,800 lb. and the thrust to approximately 3,400 lb., neglecting any consideration of cold springing.

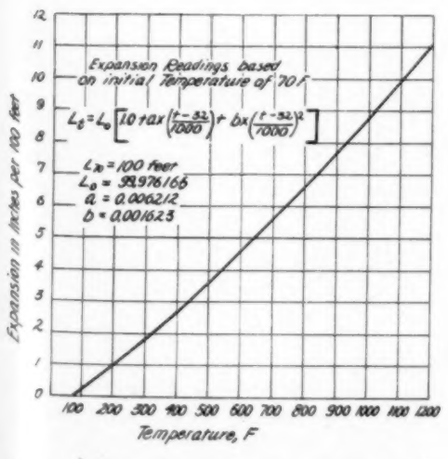

Expansion Readings based on initial Temperature of 70 F.
$L_t = L_0\left[10 + ax\left(\frac{t-32}{1000}\right) + bx\left(\frac{t-32}{1000}\right)^2\right]$
$L_{70} = 100$ feet
$L_0 = 99.976166$
$a = 0.006212$
$b = 0.001623$
Expansion in inches per 100 feet
Temperature, F

Fig. 5—Linear expansion of steel pipe From Smithsonian Physical Tables, Holborn and Day formula

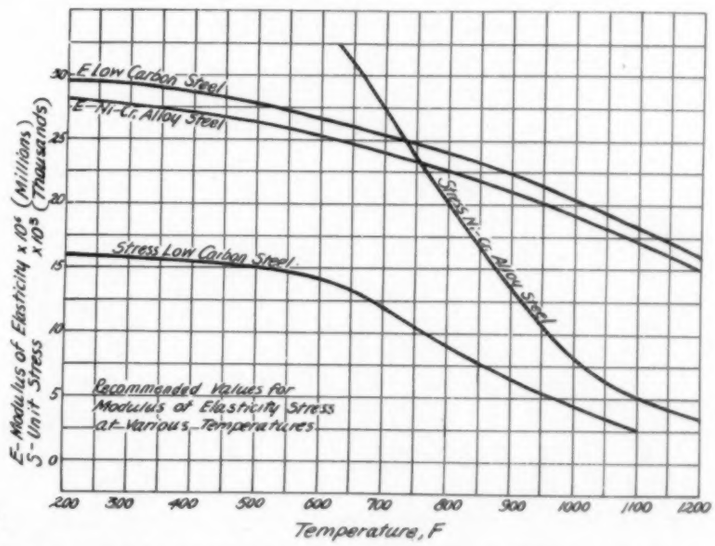

E Low Carbon Steel
E-Ni-Cr. Alloy Steel
Stress Ni-Cr. Alloy Steel
Stress Low Carbon Steel
Recommended Values for Modulus of Elasticity Stress at various Temperatures
E-Modulus of Elasticity x 10⁴ (Millions)
S-Unit Stress x 10³ (Thousands)
Temperature, F

Fig. 6—Recommended values for modulus of elasticity stress at various temperatures

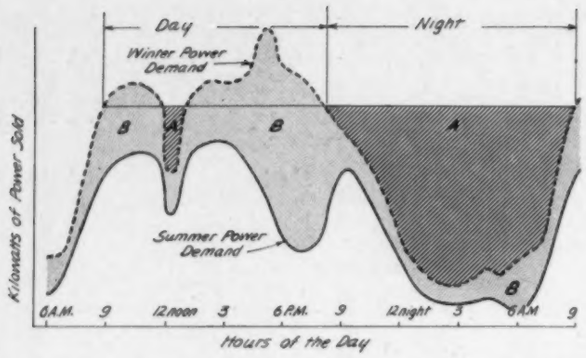


Fig. 1—Typical power demand of an electric generating company. The area "A" represents off-peak power available at low cost for heating in winter and area "A" plus "B" off-peak power available for heating in summer

By Lee P. Hynes*

Auxiliary Electric Heating With Off-Peak Power a Method of Cutting Cost

FOR large heating jobs the use of electricity must be considered with care before its adoption. The facts regarding its place in heating are too little understood by engineers, although there is general recognition that electricity is, in many cases, an ideal source of heat and particularly adaptable to exact control.

An analysis of heating and power conditions shows that it is possible to use electric heating more widely than has been supposed, as a standby or auxiliary source for large industrial plants and other buildings where actual economy in heating can frequently be obtained. It is essential, however, to understand the electrical load problems involved.

Question of Load on Generating Plant Vital

In considering electric heating, this question of load on the generating plant is vital. This factor more than any other differentiates electric heating from fuel heating because there is no economical way to store up electricity. It must be used as it is generated. Therefore, it is only possible to use electric power at any one time equal to the maximum capacity of the power generating stations.

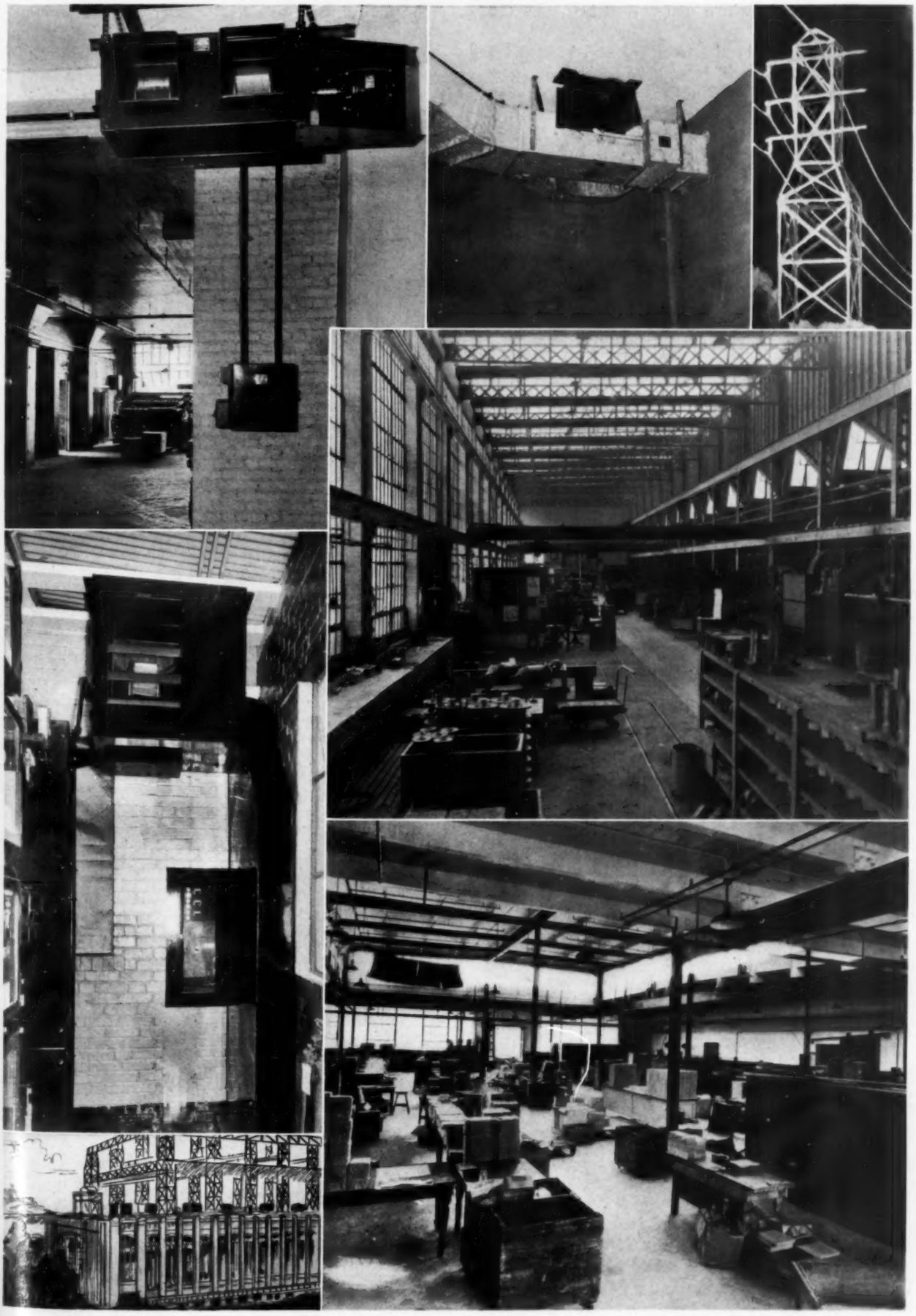
One of the major problems before the electrical industry is how to secure more uniform power load. Generating stations capable of enormous output are forced into partial idleness during many hours each day because of variations in demand. There are also seasonal variations throughout the year and the winter months show greater peaks in the power demand curve than the summer months. Even the days of the week affect the power curve because large industrial plants which are heavy users of current are generally closed over the week-end.

Power companies must provide generating and distributing equipment to meet the maximum amount of power demand and they suffer from overhead and investment charges because their load factor generally averages about 30 to 40 per cent of their maximum capacity. For this reason it is economical for them to offer low rates for power taken under control of the company as to hours of use and where no extra investment for distribution lines and transformers is required; in other words, where purely surplus power can be utilized as available, thus enabling the power company to fill in the low points of its demand curve. Power cannot be guaranteed at this low rate at all hours of the day because to do so would mean the necessity of adding to generator equipment. Neither can this service be supplied except in localities where distribution lines of ample capacity are installed and no new investment is required.

Fig. 1 shows typical summer and winter power load demand curves of one company. The winter curve differs materially from the summer curve, although in both cases the maximum peak occurs in the daytime; during the period after midnight the demand is very low in both summer and winter. The blocks of power

Fig. 2—Upper left—Heavy-duty unit heater supplying electrically-heated air in a press room requiring heat at night. Upper right—Electric booster heater installed in a duct. Lower left—A meter room heated with electricity. Right center—Foundry equipped with auxiliary electric heating. Lower Right—Paper-stock room where it is desirable to maintain moderate temperature to overcome humidity conditions and prevent freezing of sprinkler system; auxiliary electric heat is used.

*Consulting engineer, Philadelphia, Pa.

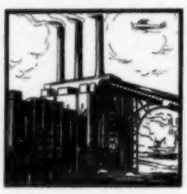


represented by A in winter and $A + B$ in summer are available for heating.

To utilize electric heating economically, it should be done in a way which will not add to the maximum demand peaks but will help utilize the blocks of power available during off-peak periods. Because the shape of the power curve varies between summer and winter and between different days of the week and may shift with the introduction of new industries into communities, it must be realized that if these blocks of off-peak power are to be sold at low rates, the hours of use must be entirely under control of the power company. This, however, does not preclude utilization for auxiliary heating as changes come gradually and there is always a large amount of off-peak power available.

Opportunities for Using Auxiliary Electric Heat

In Fig. 1, it will be noted that from about 8 a.m. until about 8 p.m. there is a heavy use of electric power except at the noon hour, due largely to the industrial load, but from 8 p.m. to 8 a.m. there is a relatively low demand for power. On the other hand, the heating demand in many industrial buildings corresponds roughly to the demand for power, namely, a large amount of heat is required during the working hours and a moderate amount during shut-down periods. There may be many parts of the plant requiring no heat at night, although other special locations do require heat. This is an unfavorable condition for the regular fuel heating plant, as it means that a relatively small amount of heat needs to be supplied at night to isolated parts of the plant supplied by long runs of steam lines and that firemen must be kept on duty 24 hours a day.



There are also plants which require little heat during the day because waste heat from lighting fixtures, motors, generators, machines, furnaces, presses, etc., provides all the heat necessary, supplemented by the radiant heat from the sun. These plants use little heat except at night time and may find considerable advantage in off-peak electric heat.

Because of these conditions, it is economically advisable for many plants having heavy electrical power demand during working hours to use their electrical capacity for auxiliary heating during non-working hours, insofar as available off-peak blocks of power can be purchased at low rates. These plants already have installed the heavy electrical supply lines and transformers necessary for carrying a heating load, and at the low off-peak rate it is often possible to supply sufficient heat for non-working periods at an actual saving over the operation of a fuel plant.

Methods of Auxiliary Heating by Electricity

This plan makes possible electric heating without any storage complications and at a minimum investment cost. It is entirely practical to employ combination systems that may be operated by either fuel or electricity. It is thus justifiable to utilize low-rate electricity when available because it is always possible to revert to the use of fuel at any time when electric power is not available.

Several types of combination electric and fuel systems are possible. For instance, electric steam boilers can be paralleled with fuel boilers and the latter can be banked at night and the load transferred to the electric boilers, although this does not permit of local applications of heat, which is often desirable. Another method is to use combination electric and steam industrial-type unit heaters from which hot air is delivered at each locality and recirculated. In this way electric heat is utilized at essential points and each heater is under local thermostatic control to insure maximum efficiency. This system utilizes the same fans, motors, etc., for both electric and steam heating and the additional investment for electric auxiliary heating is small. Existing steam units can often be remodelled into combination electric jobs.

In the large illustration is shown an installation where a heavy-duty unit heater is supplying electrically-heated air locally at night in the press room of a printing plant. The president of this company recently wrote as follows:

> "Our manufacturing building is heated with low-pressure boilers and our fires are banked at night; the building becomes cold in winter. Inasmuch as it is necessary for us to have heat 24 hours a day in our printing room, we last year installed two electric unit heaters in the press room. Each of these heaters is equipped with thermostat control so that the desired temperature may be maintained automatically at a nominal cost of power. These heaters have proven very satisfactory."

Another of the views shows a paper-stock room where it is desirable to keep moderate heat at all times to overcome humidity conditions and to protect the sprinkler system from freezing. A room of this kind is particularly suited to the application of combination electric heating at night and steam heating in the daytime; during most of the year no day heat is needed.

For buildings having air conditioning or other types of central warm air heating system with duct distribution, it is practical to install local electric booster heaters in the ducts as auxiliary heating, by which warm air is delivered at the desired temperature, automatically controlled.

Referring again to Fig. 1, it will be seen that in block B there is available, even in the daytime, a considerable amount of electrical power which can be used for a moderate amount of heating service during cool days or where it is necessary to dry out places which would otherwise be damp. The installation of an auxiliary electric-heating system thus makes it possible to shut down the fuel system during spring and fall days when a moderate amount of heat is needed, and that mostly in the early morning hours.

Supplying Hot Process Water

Another desirable use for auxiliary electric heating in summer is for supplying hot water for shower baths and similar purposes and for industrial process work. A considerable supply of this water can be heated at night ready for use in the morning and such additional

heating as is necessary in the daytime can usually be provided in the summer from the available current in block *B*. In the winter water may be heated at night from block *A* so as to start the day with a full supply and during the day when the fuel plant is operating, additional water may be heated by steam.

Companies operating large garages do most of their car washing at night and auxiliary electric heating for supplying this water in summer is often desirable. It is also possible to use combination electric and fuel heating for the hot-water supply in apartment buildings, hotels and restaurants.

Other logical locations for off-peak electric heat are in foundries, machine shops, railway stations, warehouses, churches, public auditoriums, dance pavilions, etc. A meter room heated at night with electricity is illustrated in the large cut.

Economics of the Proposition Must Be Considered

In dealing with electric heat, economics must always be considered. It may be right or wrong to use electricity according to local circumstances and nothing is more confusing than the comparison of Btu's per kw-hr. with the Btu content of fuels; usually the electrical Btu can be considered as delivered at the point of use and in the required amount with little waste or loss or labor charge. In mild weather the entire cost of electric heat at night may be less than the wages of a fireman, and frequently the heat losses in long steam pipe lines are greater than the total useful heat needed at a few isolated points during standby periods. Based on the low energy costs sometimes available, it is possible to deliver 7000 effective Btu's at the spot desired under complete temperature control for one cent.

• • • • MODERNIZE

Heating, Piping and Air-Conditioning Systems FOR EFFICIENCY AND ECONOMY • • •

The Steam-Piping System

Check-List Aids in Spotting Steam Waste

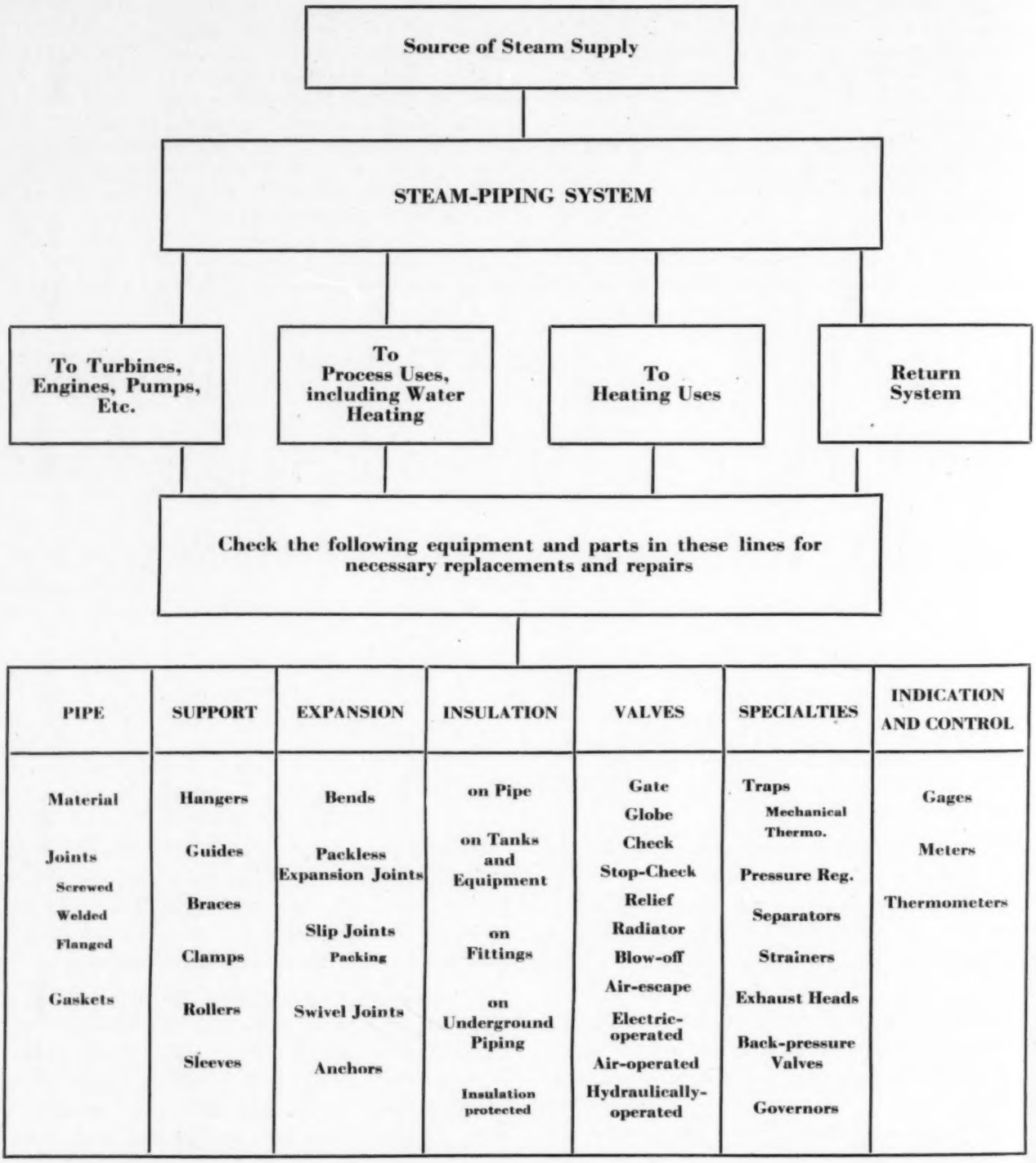
The piping of steam for power, process and heating uses in industry and large structures is a major service. Unless the piping system is designed, installed, and maintained properly it can dissipate the savings obtained by the most efficient generation and utilization equipment. The pipe itself, the valves, joints, steam specialties, measuring instruments, etc., which make up the complete piping system are all subject to deterioration with use, to breakage, or to obsolescence.

Such losses are usually hidden, often under-estimated when visible. Broken or inadequate insulation, leaky valves or fittings, defective steam traps, improper supports or guides, no meters or gages to expose sources of waste—all take their toll in many a steam-piping system.

In every plant and building, it will pay to check each part of the steam-piping system and, the check having been made, to consider the benefits to be derived from replacement with new, modern equipment or by proper repair or maintenance work.

The chart on the next page will aid in such a check-up. It lists, in convenient form for checking, the equipment and parts in a typical steam-piping system. The page opposite it outlines briefly some of the various replacement and repair operations which may be necessary. Use of this check-chart and maintenance guide will facilitate the job of spotting the places in steam piping systems which can be modernized or repaired with consequent improvement in operating economy and steam-distribution efficiency.

Modernize Heating, Piping and Air-Conditioning Systems for Efficiency and Economy — Check-Chart for Steam-Piping System



Check the equipment and parts which need attention. Replace with new, modern equipment where replacements will benefit; repair where repairs will suffice.

Maintenance Guide for Steam-Piping Systems

Check the chart on the opposite page for equipment and parts which require attention. Find below suggested maintenance and repair operations:

Pipe
- Is material proper for the service?
- Is line the proper size to avoid excessive pressure drop?
- Are there too many turns in line?
- Is location and direction proper to permit maintenance and its best use?
- Is complete replacement advisable?
- Is additional piping needed?

Joints
- Screwed
  - Pipe compound?
- Flanged
  - Faces true and clean?
  - Gaskets?
  - Bolts tightened periodically?
- Welded

Support
- Are present means of support proper and adequate?
- Is complete replacement advisable?
- Is additional support needed?

Expansion Bends
- Proper type to care for the expansion?
- Adequately supported?
- Is pipe line anchored and guided correctly?
- Are additional expansion bends needed?

Expansion Joints
- Proper type to care for expansion?
- Is pipe line anchored and expansion guided correctly?
- Packing in good condition?
- Lubrication?
- Insulation?
- Is complete replacement advisable?
- Are additional expansion joints needed?

Insulation
- Was proper type and thickness originally applied?
- Is the insulation adequately protected from damage?
  - Exposed to dripping water?
- Is the insulation in good condition?
- Are flanges, tanks, and other equipment insulated where needed?
- Is complete or partial replacement necessary?
- Is additional insulation needed?

Painting
- Is piping or insulation painted for protection?
- Are piping and valves painted for identification?
- Is complete painting needed?

Valves
- Is proper type used in each case?
- Would remote-control valves simplify operation?
- Are valves accessible for maintenance?
- Are valves leaky?
  - Stuffing box need repacking?
  - Seats and discs in good condition?
- Are proper spare valves on hand?
- Are valves tagged for identification?
- Valves operated periodically?
- Valve body tapped for drain where needed?
- Is complete replacement necessary?
- Are more valves needed?

Steam Traps
- Air bound?
- Inlet line clear and discharge line open?
- Leaky valves?
- Trap mechanism bent or broken, pivots worn?
- Valve strikes seat squarely?
- Water-logged float or leaky bucket?
- Valve orifice, proper size and clean?
- Operating mechanism powerful enough; trap right size?
- Vent provided where there is considerable distance between a unit and a trap?
- Test cocks provided?
- Valves in by-pass leaky?
- Check valve needed?
- Dirt pocket needed?
  - Trap body filled with dirt?
- Is trap accessible?
- Is complete replacement advisable?
- Are additional steam traps needed?

Thermostatic Traps
- Thermic element broken or corroded?
  - Volatile liquid missing?
- Handling water cool enough?
- Is complete replacement advisable?
- Are additional thermostatic traps needed?

Pressure-Reducing Valves
- Sized properly to avoid wire-drawing, chattering, etc.?
  - Use smaller valve in tandem?
- Does condensate accumulate ahead of valve?
  - Install steam trap to prevent?
- Control pipe arranged properly?
- Spring o. k.?
- Diaphragm o. k.?
- Seat o. k.?
- Stop valves to enable removal for repairs?
  - Install pass-by for hand control?
- Strainer or sediment trap?
  - Tee with clean-out on diaphragm chamber?
- Is complete replacement advisable?
- Are additional pressure-reducing valves needed?

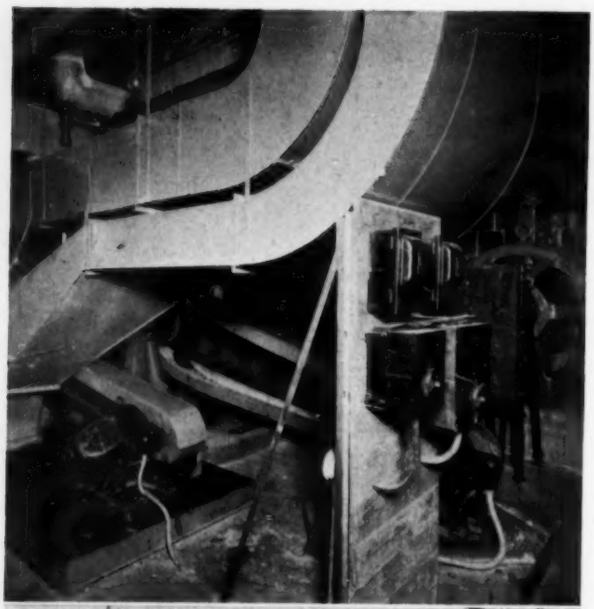
Indication and Control
- Gages checked for accuracy?
- Connections provided for portable meters?
- Gages and meters protected against damage?
- Connections to gages clean and unobstructed?
- Thermometers installed to indicate true temperature?
- Is complete replacement of gages and meters necessary?
- Are additional gages and meters needed?

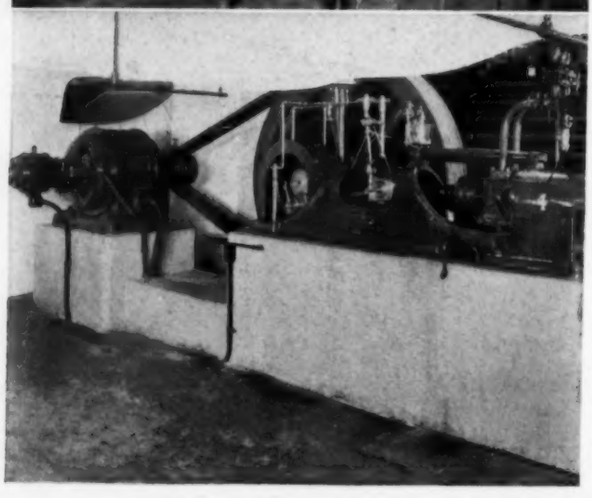
Attention to

MAINTENANCE OF MOTORS

Saves Money

THE electric motor performs its service so faithfully year after year in industrial plants and other larger structures that its ability to cope with new conditions, added burdens, or old age is not questioned nearly so often as it should be. Frequently it is difficult for an engineer to anticipate the leakage or static pressure in ducts and, therefore, difficult to select the motor of most suitable horsepower. Often the demand for air is reduced or increased, or resistance of the duct system is changed. Sometimes the motor is burned out because it is overloaded. Actual surveys show that this is a matter to which engineers seeking economy can well afford to give attention. Economies from motors driving heating, piping, air conditioning or ventilating equipment may be obtained in several ways: by replacing old motors with new, by repairs, by increasing or decreasing speed of motors to meet new requirements, by improved control, etc.





Top—Belted motors with their guards in an office building. Fans and motors are bolted to a metal-covered platform which floats on a layer of cork. The ducts and other contact points with the building structure all are noise-insulated

Bottom—A 40-hp. motor driving a compressor for an air-conditioning plant. Power is transmitted through a multiple-strand V-belt. The induction motor has an exciter mounted on the end of its shaft

Causes of Losses in Motors

An electric motor essentially is made up of a number of magnets arranged so that they can never quite touch each other, and so related that their force results in rotation of a shaft. The output in measurable power at the shaft compared with the input in electrical energy through the feed wires to the magnets expresses the efficiency of the motor.

The electric motor loses part of the energy input in the form of heat radiated from the magnets and in overcoming the friction of the shaft bearings. The electric motor must circulate air through the windings of the magnets and must pump oil into its bearings.

A motor which is too big for its job is inefficient, not only because of the unnecessary investment in surplus metal, foundations, connections, etc., but also because of the energizing of an unnecessary weight of copper and iron, and because of the moving of this excess weight.

If the motor is too small and is given an extra burden it will put forth extra effort and will carry more than its proper share for a time. If the overload persists the motor will overheat and eventually will burn out. Burning out means usually that the windings have become so hot as to break down the insulation which separates the wires, resulting in short circuits.

Motors Driving Centrifugal Pumps or Fans

The demands placed upon electric motors in heating, cooling and air-handling are specialized.

For instance, motors used to drive centrifugal pumps have rather an easy time, provided that they have been selected wisely as to size and speed. An installed motor-driven pump may require 4 hp. under its maximum

load and may have a motor which will transmit this amount of energy. If anyone throttles that pump momentarily, or if he adds higher stories to the building or does anything else which results in the pump (*without changing the original speed*) having more pressure to overcome, the load on the motor is reduced. Because of the characteristics of such a fan or pump, the volume of the output is automatically reduced to compensate for the pressure increase up to the pressure-speed limit, and thereafter the power input is reduced in proportion as the output is reduced.

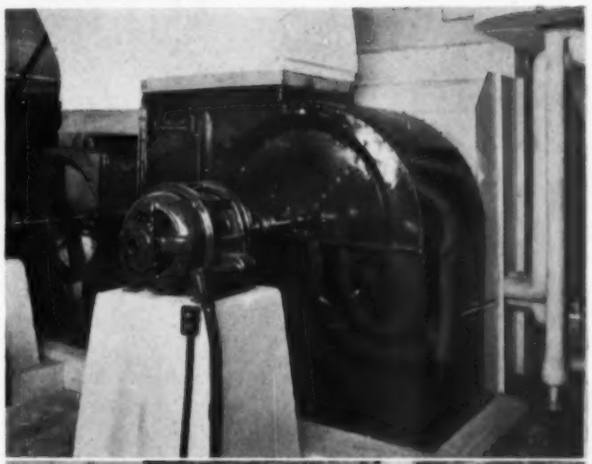
In other words any motor which drives a centrifugal pump or a centrifugal fan requires less power and delivers less material as the resistance increases, provided that the speed is not increased.

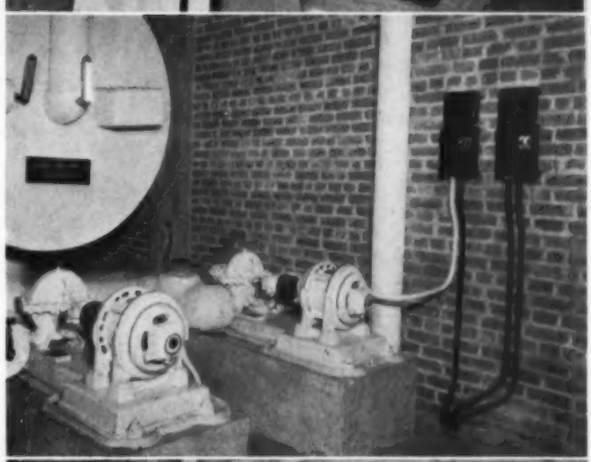
Conversely, if a centrifugal pump or a centrifugal fan driven by a motor is maintained at constant speed but the resistance or pressure is reduced, as would be done by serious leaks in the piping or ducts, the pump or the fan will handle more material and will require more work from the motor, which may cause distress for the latter.

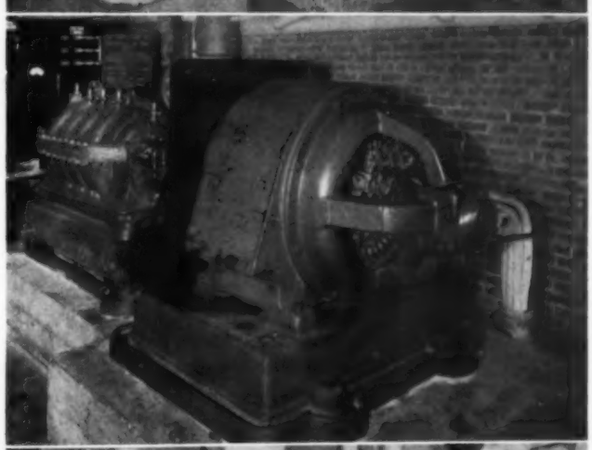
Until recently, designers of ventilating systems using centrifugal fans were compelled to install motors of excess weight and ability for fear that at some future time a door or a damper might be left open into the duct system so as to reduce the resistance and increase the air output, overloading and burning out an otherwise adequate motor. It is possible now to obtain housed wheels having such shape as will cause the air output and power to increase as the resistance decreases only up to defined and reasonable limits, so that smaller motors may be used.

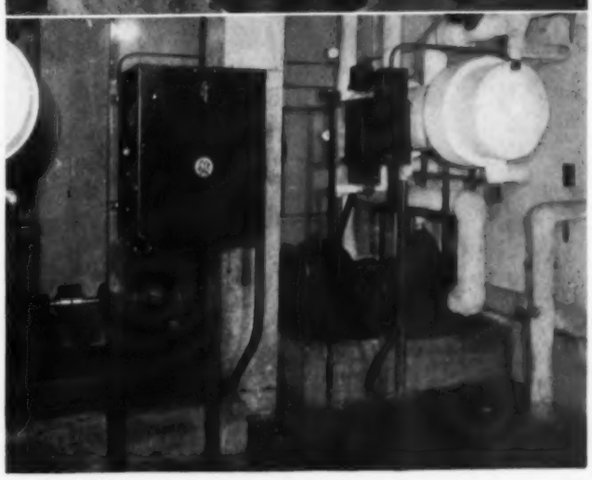
Motors Should Have Protective Devices

It is practicable and routine practice, of course, to provide all fan and pump motors with heat-sensitive protective devices which operate automatically to stop the motors when they become warmer than certain predetermined limits.









Top to Bottom

Direct-connected fan motors of the induction type. While they are efficient as to transmission of the power through the shafts, large motors must be used because of the necessarily slow speed permissible

Direct-connected pump-driving motors used for circulating brine in an air-conditioning plant. The pump speeds in these units are better adapted to efficient motor speeds than usually is possible when the motors are direct-connected to fans

A 200-hp. fire-pump motor, an ideal application of the ever-ready feature of electric power

Induction motors driving circulating pumps in connection with air filtering equipment. The pump and motor shafts are joined through flexible couplings. The pump speeds are adapted to the motor speeds

Often Desirable to Use Speed-Reducing Transmission

Within reasonable ranges the more rapidly a motor revolves the more energy it may transmit per unit of material in the motor. Thus the same machine which transmits 15 hp. at 840 r. p. m. may transmit 20 hp. at 1,145 r. p. m. and 25 hp. at 1,720 r. p. m. This makes it desirable to use an efficient speed-reducing power transmission in many cases, such as a modern rubber-covered textile V-belt, a flat belt with an automatic belt-tightener, a chain drive, etc.

Frequent Ammeter Readings Keep Cost Down

One advantage of electricity is the ease with which the electrical input to a motor may be measured. In industrial plants and other buildings having many motors and varying loads it is wise for frequent ammeter readings to be taken so that the belted motors may be replaced or transposed, thus keeping the size of each machine nearly suitable for the work which it must do.

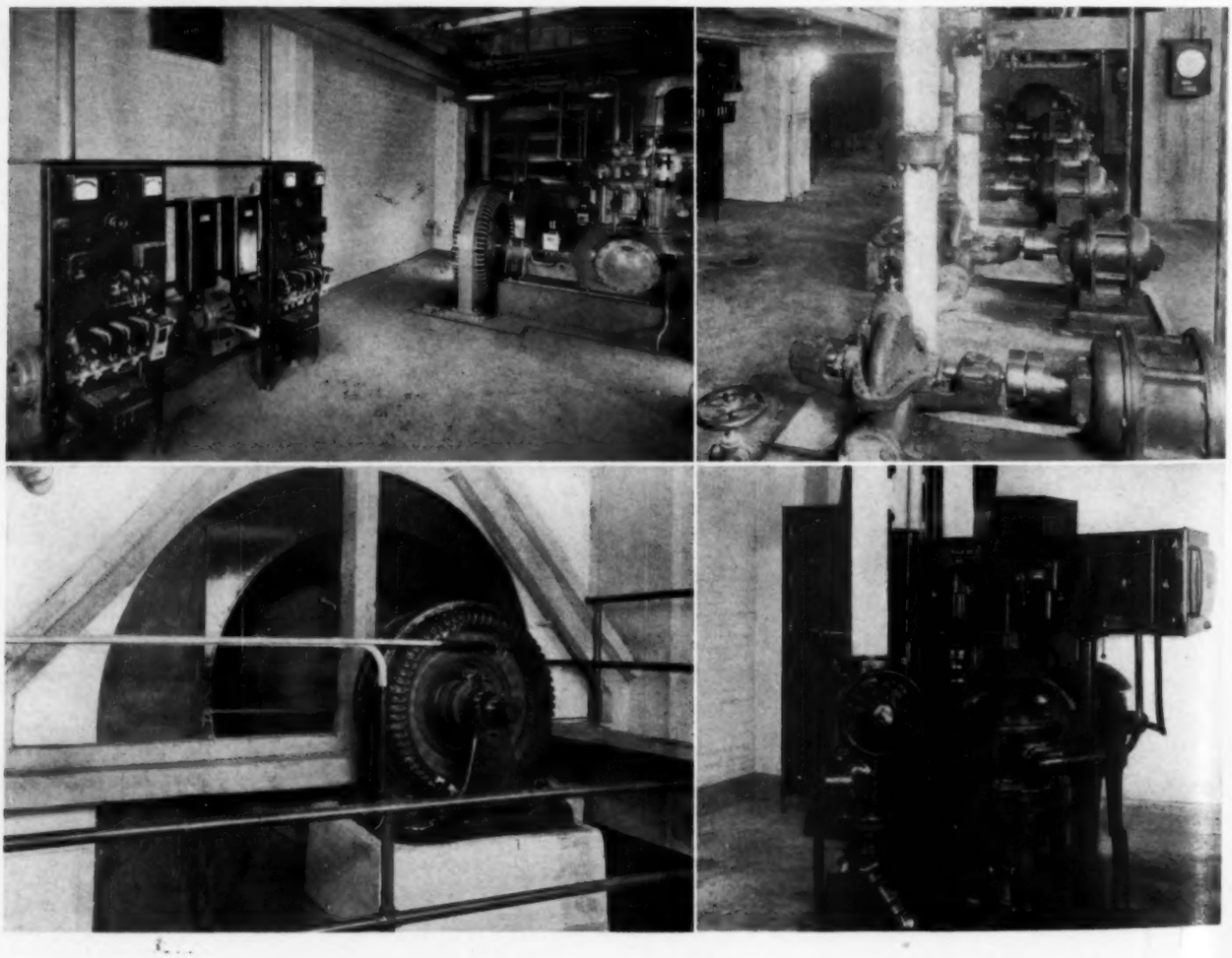
Failure to do this may result in unduly high operating costs on account of poor mechanical efficiency; also, if the connected load is greater than the demand load, the customer is not buying his power economically. One manufacturer who uses large power in many small motors requires frequent reports by maintenance men of all motors which are cool to the touch. Such motors are under-loaded, and it pays to swap them around until each one is fairly loaded.

Top left—Two large synchronous motors direct connected to refrigerating compressors; such motors are especially adapted to heavy duty and steady load. The exciters for these motors are at the rear of the control panels. The characteristic appearance of the synchronous machine is due to the revolving field

Lower left—A large direct-connected fan-driving electric motor. This synchronous machine is placed in the airway and endures all of the elements which may enter with the air

Top right—A line-up of 7 direct-connected electric pumps such as may be found in service in any large modern building

Lower right—Vertical motors operating pumps submerged in the drainage tank. These usually are so controlled that one machine operates automatically, with the second machine cutting in only in case of failure of the first machine or in case of a sudden rush of duty which overwhelms the first machine



ON THE JOB

. . . a department devoted to short, practical articles on the installation, operation and maintenance of air conditioning, heating and piping equipment . . . . . .

Using Pipes as Beams

. . . . *By* M. Barry Watson*

STRUCTURAL supports for tanks and other heating and piping equipment frequently are built up from standard pipe and fittings, rather than from structural steel. It is doubtful whether pipe supports are quite as cheap as those of structural steel if properly designed and built for the same service, but generally the pipe cutters and dies are on the job, and the men doing the work are more accustomed to measuring and erecting pipe than structural shapes.

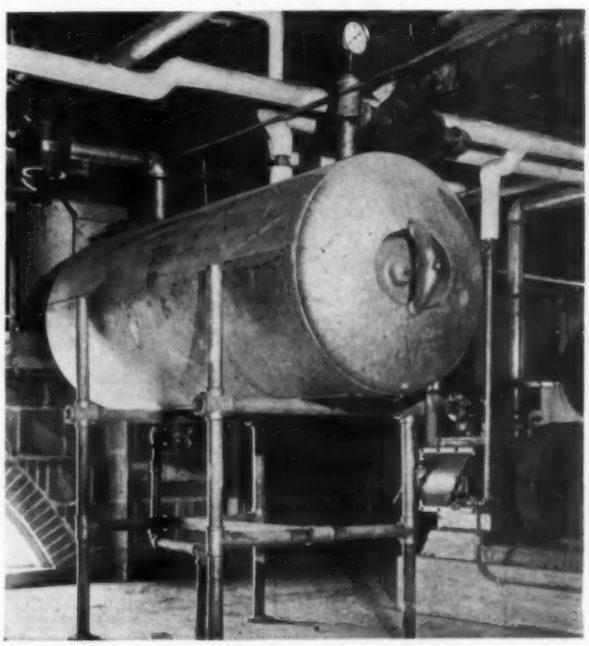
In general maintenance and industrial plant repair work, temporary structures and supports are often required, and it is frequently found that there are on the job some spare lengths of pipe which can be pressed into service. Thus it is often convenient to use iron pipe as beams, columns or struts.

Serious accidents, lost time and other needless expenses and worry have been caused by pipes being used for this type of service where the strength was not considered. On the other hand, if one must calculate the section modulus of a piece of pipe before he knows whether it will be suitable for a particular job, considerable time may be wasted while the work is held up.

Chart Simplifies Use of Pipe as Beams

The author has had occasion to design a number of stands for tanks, heaters, etc., to be built of pipe. To simplify such work the chart published here for the design of the horizontal load-carrying members of such structures has been prepared. It is a valuable time saver.

The chart is based on standard-weight steel pipe, loaded to a maximum fibre stress of 18,000 lb. per sq. in. Considerable discretion must of course be applied to such designs when "used" or rusted pipe is to be incorporated in the structure. The author always specifies that new pipe must be used for all load-carrying parts of permanent structures, though old or internally rusted pipe may often be used for cross-bracing, etc. Some latitude may be allowed in applying this chart for use with extra strong or double extra strong pipe. When used as a beam, extra strong pipe may safely be loaded 20 per cent more than standard weight pipe, and double extra strong may be loaded 60 per cent more than standard.



It is better practice to support round heaters, tanks, etc., by means of bearing surfaces rather than to allow them to be supported directly on the pipe beam

Use Bearing Surface to Apply Load

The maximum concentrated loads shown may be safely applied only on formed saddles or bearings equal in length to the nominal diameters of the pipe. Such saddles may conveniently be made from extra-heavy cast-iron tees drilled through the run to a close fit over the pipe; satisfactory end supports may consist of extra-heavy cast-iron screwed fittings, provided the pipe has a clean thread and is screwed home into the fittings.

In most cases flat surface bearings are used to apply the load, and to support the pipe beam; to prevent crushing the pipe, the line of contact should extend a sufficient distance along the pipe to produce unit loading per inch of length of not over 600 lb. for standard pipe, or 200 lb. if standard-weight boiler tubes are used. In

* Consulting engineer, Toronto, Canada.

no case should a round heater or tank be supported directly on the pipe beam, but a flat plate or a saddle should be placed between them.

Choosing Support for a Tank With the Chart

The following example illustrates one of many problems in which this nomograph may be used: Required to design two pipe frames or trestles to support, when spaced symmetrically, a horizontal circular tank 12 ft. long and 42 in. in diameter, full of water.

A tank of this size for 125 lb. pressure will weigh about 1950 lb. Allow 50 lb. for pipe connections, etc. The capacity of the tank is 860 gal. or 7160 lb. of water, and we will assume a total load of 9200 lb. or 4600 lb. on each frame.

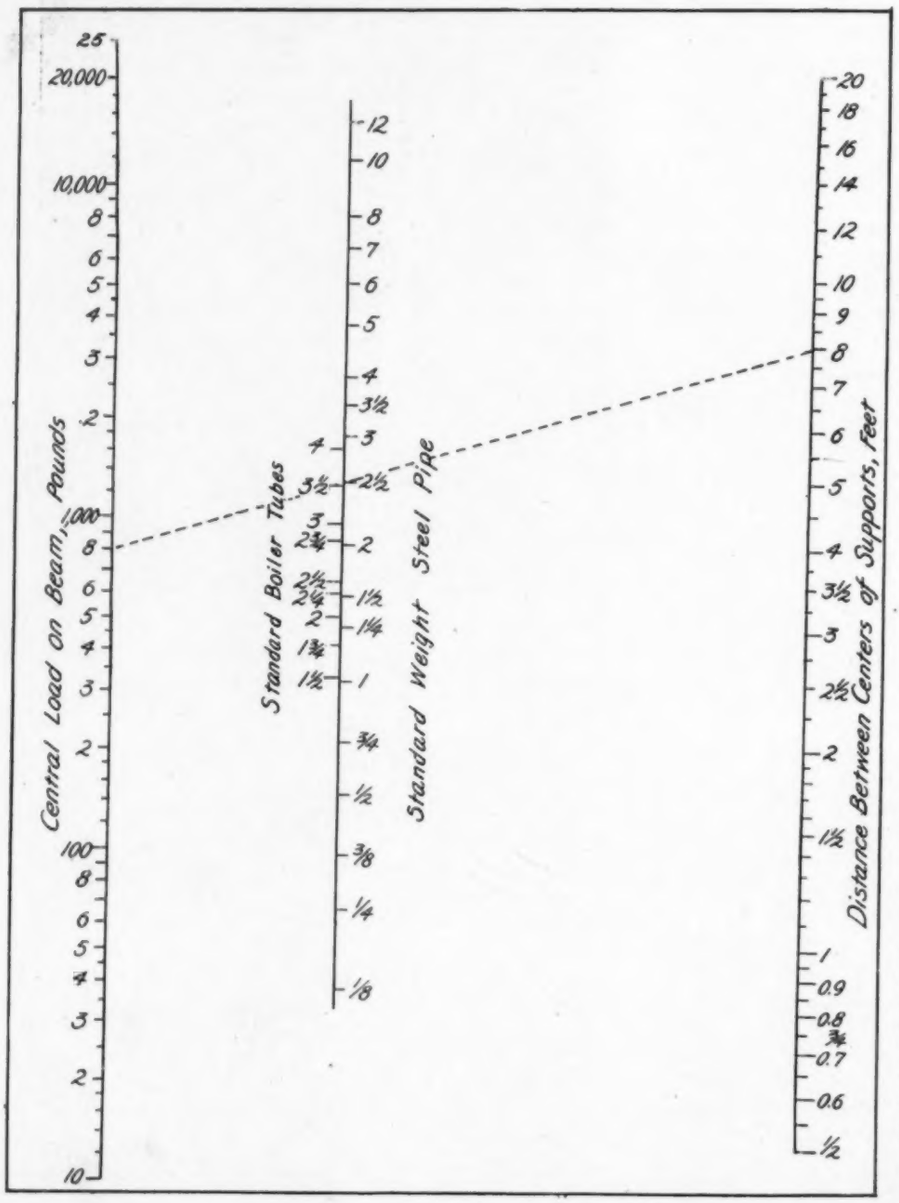
The distance between centers of supports must be more than 42 in. if the vertical posts are to extend up beside the tank. We shall therefore assume a length of 48 in. for the beam. Joining the 4600 point on the load scale with the 4-ft. point on the length scale on the chart, we find that a 4-in. pipe is liberal in strength.

Where more accurate work is required, one-half the weight of the beam chosen must be added to the actual load to be used as the effective concentrated load on this chart. In this case the weight of half this pipe beam is only about 20 lb., and we made allowances of more than this in totalling up our load; also the 4-in. pipe was found to be considerably stronger than necessary.

The Bearing Plates:

For this example we shall use flat bearing plates and the load per inch of length must not exceed 600 lb.; the bearing plates must therefore be at least 7¾ in. long. Using 8-in. square plates, we can calculate the thickness required at this loading to give the same stress in the plate as in the pipe and find a ¼-in. plate necessary.

For temporary work planks may be used in place of plates, and may be loaded slightly more because they tend to fit the curved surface of the pipe; good judgment is required in such use. Square steel plates are the simplest method of transferring loads through one line contact to another; these must be centrally placed as regards the lines of contact. The limiting sizes for square plates suitable for the required conditions are shown on the next page. Where a greater thickness than 1-in. plate is required, there is little doubt but that structural steel framing will be cheaper than pipe.


Central Load on Beam, Pounds
Standard Boiler Tubes
Standard Weight Steel Pipe
Distance Between Centers of Supports, Feet

Safe loads for pipe used as beams in supporting tanks, heaters and similar equipment are shown by this chart

Maximum load indicated may be used ONLY with bearing plates formed to shape of pipe, length equal to diameter.

To prevent crushing, maximum load should not exceed 600 pounds per lineal inch of FLAT bearing plate for pipes. 200 pounds per lineal inch of FLAT bearing plate for tubes.

If load is in two equal parts at 1/3 points of beam, or in three parts at ¼ points, multiply load by 1½.

If load is evenly distributed over length of beam, multiply allowable load shown on chart by 2.

One-half the weight of the pipe must be deducted from chart reading to obtain net central load.

Plate Thickness, Inches	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
Square,	2½	3½	5	6½	8½	10¾	13½	16½	20

Getting a Boiler Across a Gap

This chart will be found useful in the solution of a problem of this kind: How many 10-in. pipe skids are needed to carry a 60,000-lb. boiler across an 8 ft. gap?

Assume the center distances of supports to be 9 ft. Join the 9-ft. point on the length scale with the 10-in. pipe size and read 20,000 lb. on the load scale. Obviously three pipes are required.

The chart does not give any data on the use of pipes as columns, struts or posts; this will be discussed (with a similar design chart) in an early issue.

Spot Welding Stainless Steel Sheets

By V. W. Whitmer*

CORROSION-RESISTANT metals of various kinds are used extensively in ducts for ventilating and exhaust systems where battery fumes, plating room vapors, exit gases from acid processes, etc., are to be handled. Among metals so used are the stainless steels.

Stainless steels are particularly well adapted to spot welding which is done by holding two sheets in close contact between two copper electrodes about an inch or so in diameter with the contact ends tapered to about ⅛-in. diameter, and passing a current low in voltage but high in amperage through the circuit for a short period. Fusion takes place between the two sheets, while the excess heat is carried away from the outside surfaces by the water-cooled electrodes. The low voltage, about 2 to 4 volts, is obtained from a step-down transformer wound in sections, each being connected with a stop on a rotary control switch by which the current or heat can be increased or decreased by turning up or down respectively.

While the total heat applied is determined by the rotary adjustment, the area of the electrode points should be maintained as near constant as possible. An increase in area will tend to reduce the heat per unit area, which may result in an improperly or poorly fused joint. A decrease in area will increase the unit heat, which may burn a hole entirely or partly through the sheet to be welded, other factors remaining constant.

Pressure Has Effect on Weld

The pressure exerted by the electrodes is generally produced by the compression of helical springs and can be adjusted by a lock nut on a shaft through the center of the spring. Variable pressures will also affect the quality of the weld, too much pressure reducing the resistance of the joint and tending to decrease the heat generated. The pressure generally determines the amount of up-set displacement directly following the fusing period, producing an indentation on each side of the sheets.

In addition to these variables, the time of current flow is of great importance. Too long a period gives the same result as too much heat. Too short a contact will produce no weld.

The Welding Procedure

It is evident, therefore, that spot welding depends on these variables:

Current (controlled by rotary switch).
Diameter of electrode contact points.
Pressure (controlled by spring or pneumatic pressure).
Length of time the current is allowed to flow.

While it would not be impossible to determine an adjustment of each of these with respect to the other for each gage to be welded, as in the case of automatic machines where time and pressure are accurately controlled by motor-driven cams and the current set by hand, it would be next to impossible to determine them for manual operation, due to the personal element. Furthermore, such adjustment would be necessary for each individual machine. This makes it impossible to set up a specific procedure to follow for this class of work. However, stainless steel in general will require less heat than the same gage in common steel, due to its lower heat conductivity (tending to concentrate it in one spot), its lower melting point and better contact due to a scale-free surface. Consequently, if good work is being produced on, say, 20-gage black steel, in general a change could be made to the same gage stainless by either dropping the switch one point or reducing the time slightly, or both. The exact procedure must be worked out for the individual case, balancing one variable against the other until the desired result is obtained.

Reducing Depression in Sheet

If both electrodes are of the same diameter, a depression will occur on both sides which, while not serious on the pickle finishes, can be reduced by using a copper block about ½ in. thick and 2 in. square between the electrode and the outer side, thus putting the major depression on the lower side. An aluminum block ⅛ in. to ¼ in. works even better but due to its lower melting point, will tend to pit if a slight arc is drawn. This procedure will reduce the depression but will not eliminate it entirely, as it is due to shrinkage of the molten metal in the center and hence, pulls from both surfaces. If necessary, the indentation remaining can be ground out with a cotton wheel set up with glue and abrasive. (About 80 grit or finer.)

Oxide Formed is Surface Condition

Spot welding, like any other type of welding requiring high temperature, will form an oxide on the surface which will be blue in color. If this is exposed to the weather or moist conditions, it will slowly change to a brown color resembling rust: this is only a surface condition, affecting the original oxide only.

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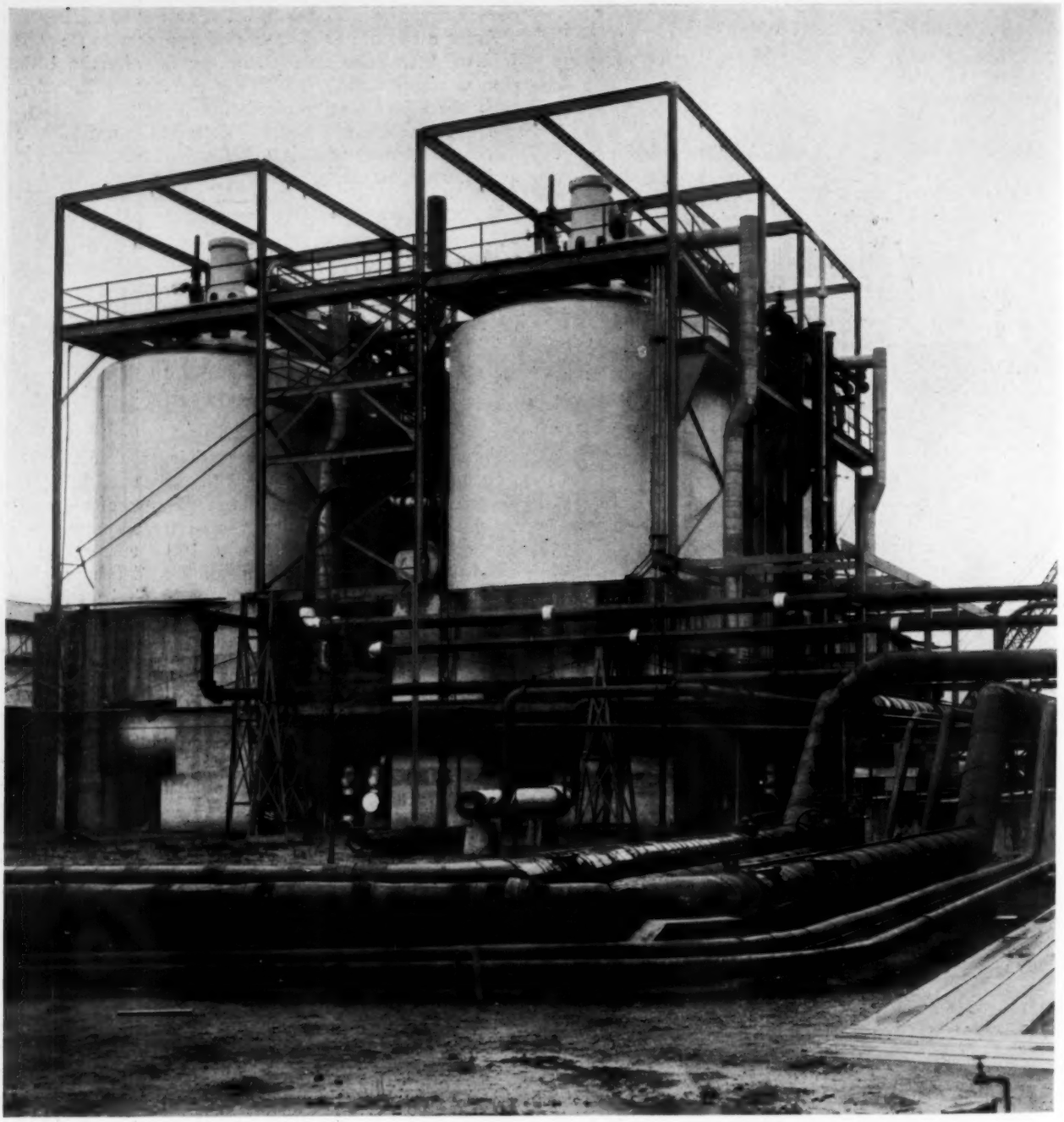

"Not only is it the finest article I've ever read on the causes of piping corrosion, but from comments made by my engineering friends I know it was well-received by the readers of HEATING, PIPING AND AIR CONDITIONING," says a prominent engineer in referring to the paper by C. E. Joos and V. A. Rohlin in the August number, of which this is the third and final installment.

The present article by these same authors tells how deaerators may be installed to protect the piping in industrial plants, office buildings, hotels, schools, hospitals and other large buildings from the ravages of corrosion and loss of capacity. Important always, maintenance of piping in "A-1" condition is of prime importance now, both for present operations and for increased use of industrial and commercial piping systems in the future.

There are several methods of preventing corrosion of piping; careful study of the individual installation is advisable so that the right one—from the engineering and economy viewpoint—may be chosen.

Combating Corrosion of Piping in Plants and Buildings

By C. E. Joos* and V. A. Rohlin†

MAINTENANCE of industrial and building piping to prevent failure because of corrosion and loss of capacity due to choking up by the products of corrosion is an important economy measure which should not be overlooked. Among the preventive measures available are the use of the proper piping material, chemical treatment of water, removal of dissolved gases by heat, etc.

In the August issue, the causes of corrosion were explained in detail; last month, deaeration to prevent corrosion of piping was discussed. This article shows methods of installing deaerating heaters to give such protection, the typical cases considered being particularly valuable.

As with most engineering problems, the correct answer to the problem is determined by the circumstances of the individual installation, which should be carefully studied.

Methods of Installing Deaerating Heaters

Because of the importance of protecting hot water service and condensate return lines, it is well to discuss methods of installing deaerating heaters for this purpose.

Supplying Mains by Gravity:

If the deaerator for heating the water and deaerating it to reduce its corrosive tendencies can be located at the elevation of the highest point in the building the hot water mains throughout the building can be supplied directly from the deaerator by gravity. Such an arrangement is illustrated in Fig. 2, the building in this case being divided into upper and lower zones, with a pump to supply the higher floors. The latter is necessary as the water and vapor space in the deaerator is normally under a vacuum of from 15 to 20 in. of mercury, so that the upper floors, within 20 to 25 ft. of the deaerator level, cannot be supplied by gravity. Placing the deaerator at the top of the building necessitates bringing steam for the deaerator to this point, but in steam-heated buildings there is usually a steam riser from which the steam can be drawn.

Fig. 1—(Opposite) What is believed to be the largest hot process water softener in the world supplies the Texas Gulf Sulphur Company's plant at New Gulf, Texas, with hot soft water free of dissolved oxygen, protecting miles of piping that must be kept in service. Total capacity is 420,000 g.p.h.

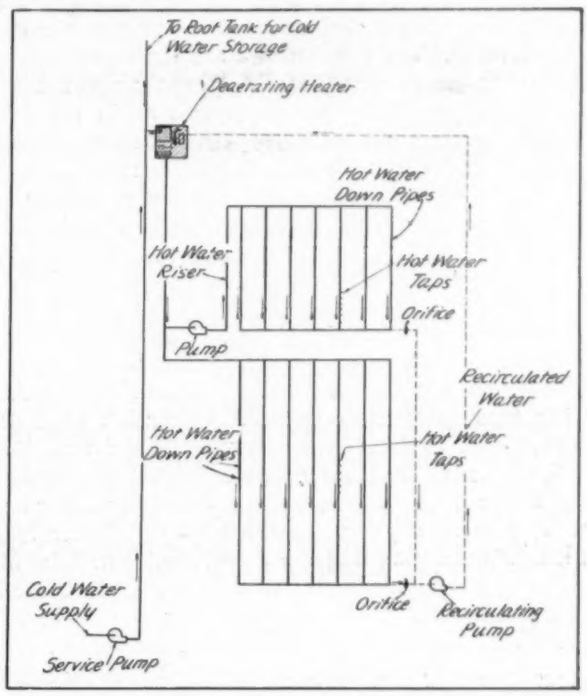

Fig. 2—Deaerator at top of building, with pump to supply upper floors

When Demand for Hot Water Fluctuates:

If the demand for hot water fluctuates widely, it may be desirable to provide sufficient water storage to smooth out the load, and in that way to create a more uniform demand for steam. Fig. 3 shows an arrangement in which a deaerator in the basement supplies hot deaerated water to a storage tank on or just beneath the roof, from which it gravitates through the several supply lines. The storage tank is arranged to be sealed against atmospheric air and oxygen.

If the tank is properly lagged, the water can be kept hot for hours and the tank can thus supply hot deaerated water when no steam is available. If centrifugal pumps are used, the storage tank may be controlled automatically to reduce the pumping charge, since such pumps are inefficient when little or no water is being used. If the deaerating heater and pumps are to be shut down for periods of several hours, it may be desirable to install a small surface-type heater for recirculation. If no steam is available during the shut-down period, recirculation can be accomplished by a small motor-driven pump delivering the water to the storage tank. This is

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not advisable unless the storage tank is of adequate size, as the admission of cold water from the lines will otherwise too greatly reduce the temperature of the stored water.

Deaerator Installed in Basement:

In Fig. 4 the deaerator is installed in the basement and deaerated water is pumped to a float-controlled water-storage tank from which water is supplied by gravity to the several zones in the building. Pressure-reducing valves are used to avoid excessive pressures in the intermediate and lower zones and separate recirculation heaters are installed to avoid re-pumping the circulated water. The upper floors are shown as fed by gravity but the feasibility of supplying the upper floors with water by gravity would depend, as in the first example, on the static head available. The arrangement shown in Fig. 4 is particularly applicable to high buildings where the pressure at the lower floors, because of the static head from the roof tank, would be objectionable.

Deaerator and Storage Tank in Basement:

In some cases it may be desirable to install both the deaerator and water-storage tank in the basement, and for a lay-out of this type the arrangement shown in Fig. 5 has been successfully applied. It consists of a deaerator with a closed-type storage heater installed at a slightly lower level and so arranged that the storage-type heater can be equalized to the deaerating heater and operated as a storage tank with a varying water level when the deaerating heater is in service. The float for operating the regulating valve which controls the admission of water to the deaerating heater can, in this case, be placed either in the deaerating heater or in a float box equalized to both the deaerating heater and the storage tank, with provision for isolating it from the latter. As the effective water storage is measured by the volume between the high and low positions of the float, a liberal float travel should be provided. This arrangement has the advantage of providing a spare heater which can supply the building with hot, although not deaerated, water in the event that the deaerator is out of service.

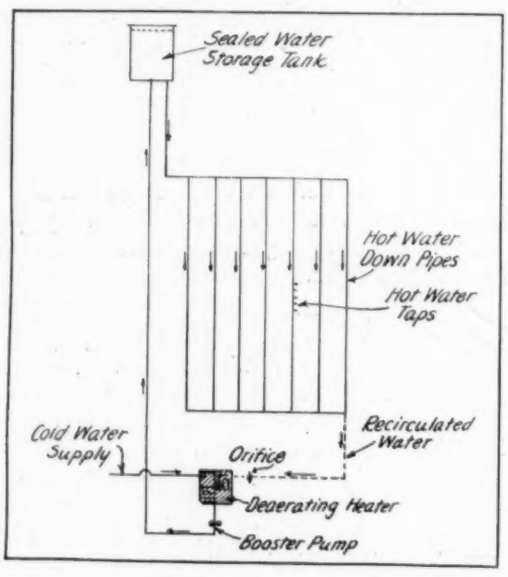


Fig. 3—Deaerator in basement, with pump to supply storage tank on roof

Deaeration of Condensate Returns

Return condensate from vacuum heating systems contains no hardness, is normally high in oxygen, and low in *pH* value because of CO_2, giving the water intensely corrosive qualities. The oxygen is due to inleakage of air through shut-off valves, pumps, etc., and absorption of air also occurs where the condensate is returned to an open expansion or surge tank. If means are not provided for degasification of the returns, serious corrosion of return lines and of steel heating boilers may result. A section of piping taken from a condensate return line which runs only partly full showed more corrosion on the bottom of the pipe, where the oxygen is dissolved in the condensate, than in the upper half.

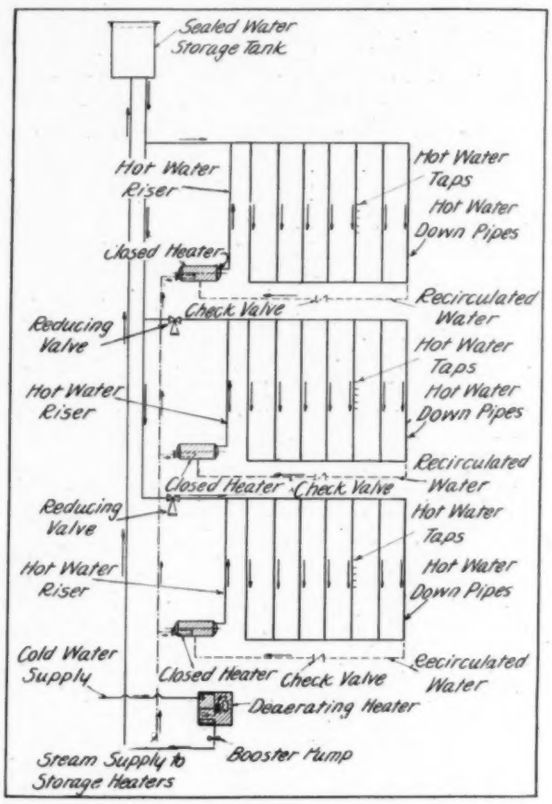


Fig. 4—Deaerator in basement with tank on roof supplying lower floors through pressure-reducing valves

The low *pH* value of condensate is commonly due to the CO_2 gas generated by breaking up of bicarbonates in the boiler. A portion of this gas redissolves in the condensate, and reduces the *pH* value to 5.0 or 6.0 or lower, depending upon the amount of CO_2 generated and the temperature of the returns leaving the heating system. In districts where the make-up is high in carbonates or is treated in a zeolite softener, the generation

of CO_2 will be sufficient to give the condensate a distinctly acid characteristic; while this alone may not cause corrosion in the absence of oxygen, it is a rapid accelerator of corrosion where oxygen is present.

It is therefore quite obvious that in such heating systems where infiltration of air is unavoidable, corrosion is rapid. An excellent paper covering the details of factors entering into the corrosion of condensate return lines was recently presented by Hall and Mumford.[1]

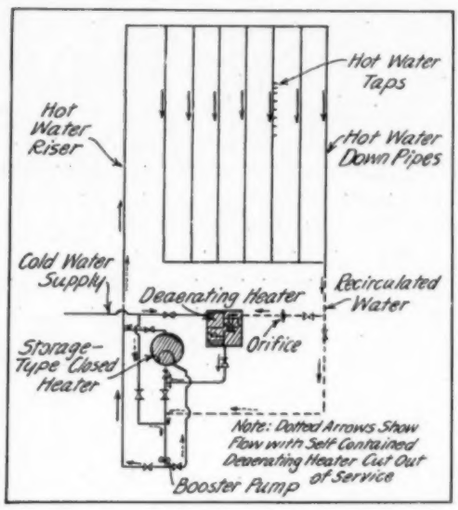


Fig. 5—Deaerator and storage tank in basement

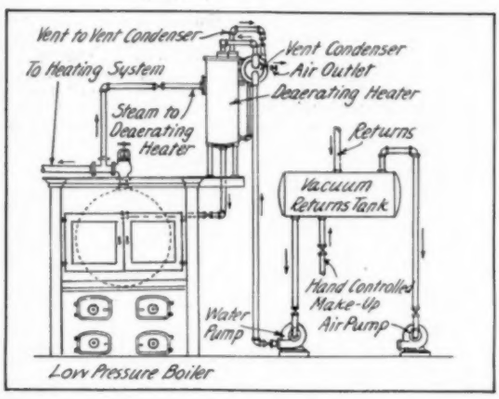


Fig. 6—Deaerating heater installed to protect low-pressure boiler and steam piping in heating system

An interesting experience may be cited to illustrate this point. At Cornell University, Ithaca, N. Y., a group of buildings is supplied with steam from a central heating plant. Originally the returns were pumped through miles of return lines back to the central plant; rapid deterioration of the return lines resulted. At the present time, each building is equipped with a deaerator which removes the oxygen and CO_2 from the vacuum pump discharge, giving protection to the mains.

With small installations the damage may be most pronounced in the steel boiler, in which case deaeration can be provided as generally illustrated by Fig. 6.

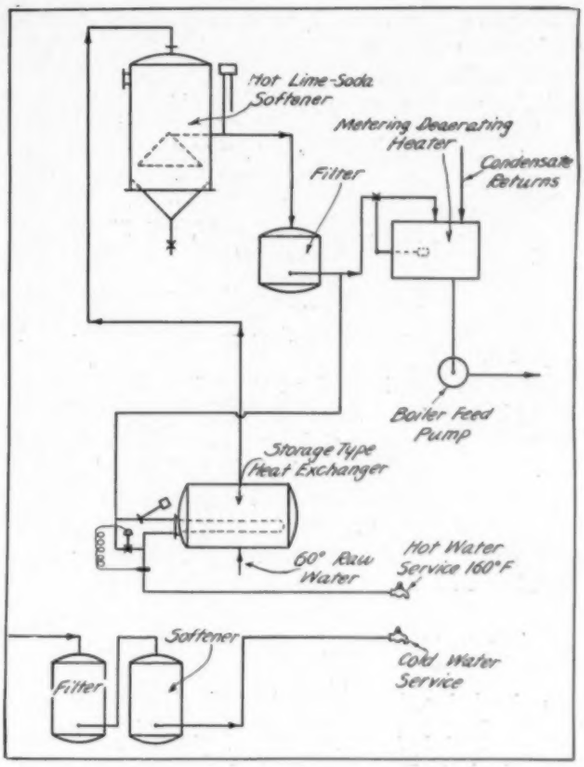


Fig. 7—Installation of water softener for supplying hot service water and boiler feed

Protecting Piping in Central Heating Plants

The central heating plant in an institution is usually given the responsibility of supplying steam, as well as hot service water, and in hard water districts the service water, both hot and cold, is softened. Here the problem takes on the aspect not only of protection of lines against corrosion but the protection of the boilers against scale, corrosion, and embrittlement, as well as minimizing tendencies to foam and prime and thus contaminate the steam.

For the protection of large boilers, particularly high-pressure boilers, deaeration and softening are deemed essential. In many cases the process of heating, softening and deaerating a feed-water can be combined with the provision of hot service water, and the installation greatly simplified. For the protection of large high-pressure boilers, a hot process lime and soda system effects a desirable treatment, as well as being low in cost. The properties that are given to the boiler feed-water as a result of the hot process softening treatment are also suitable for the protection of hot-water service lines, as well as giving the water a degree of softness that makes it satisfactory for laundry use.

The hot process lime-and-soda system brings about these conditions by first degasifying the water by means

[1] Some Fundamental Considerations of Corrosion in Steam and Condensate Lines, by R. E. Hall and A. R. Mumford, presented at the 38th annual meeting of the *A. S. H. V. E.* and published in HEATING, PIPING AND AIR CONDITIONING, November and December, 1931.

of an open or deaerating type of feed-water heater. The heated water falls to a sedimentation tank where the chemicals, lime and soda ash, are introduced. Here the hardness, as well as any carbon dioxide gas that might remain, is removed. From the sedimentation tank the water is passed through a filter and thence to the boilers or to the hot-water service system. The chemical treatment leaves a small excess of soda ash in the water, which gives it a relatively high *pH* value. Water softened by this process will show a *pH* value usually averaging above 9, with complete elimination of carbon dioxide and oxygen. The University of Michigan uses this type of system.

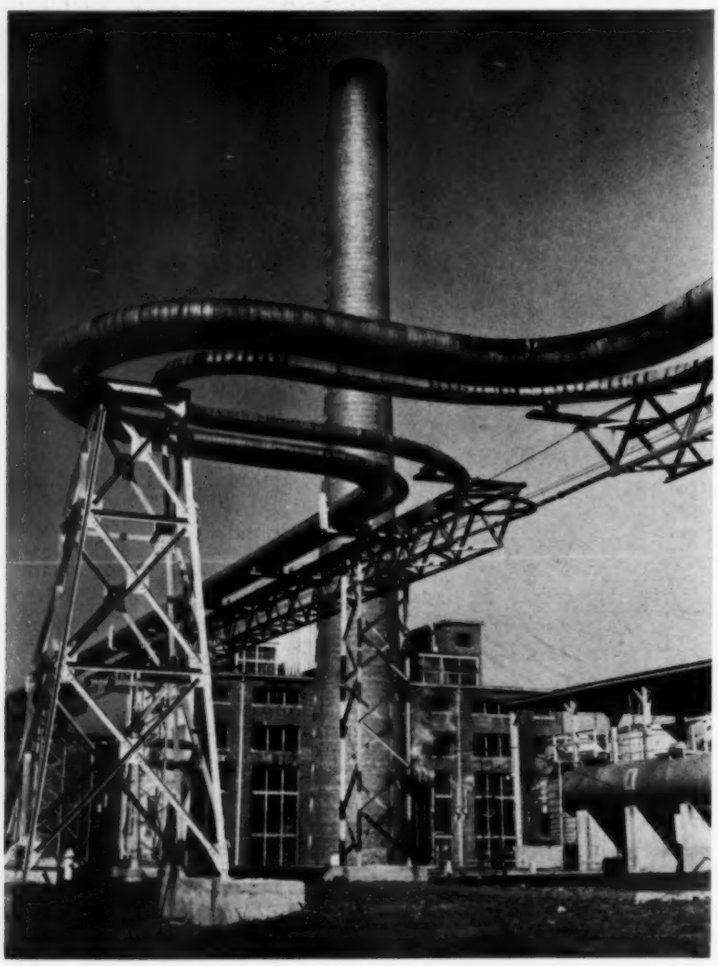
The water for the boilers, as well as the water used for the hot-water service, is prepared by the hot process lime-and-soda softener and results have been gratifying. Fig. 7 illustrates the method of employing such a system in connection with boiler feed as well as hot service water. Such a system is particularly well adapted to districts of high carbonate water, where softening is considered essential.

The Protection of Industrial Piping

In the industries, prevention of pipe corrosion and deposits is far more important than is customarily thought. The sulphur industry, for example, must consider the problem of corrosion and deposits in pipe lines of major importance. Sulphur is mined hydraulically by pumping hot water at 320 F to the sulphur beds, melting the sulphur and lifting it to the surface by means of an air lift. The sulphur beds occur in domes and the ground surface gradually sinks into valleys with the removal of the sulphur beneath. It is, therefore, impossible to locate the hot-water preparing equipment near the mines, but rather at quite a distance, say, five or six miles. Such an operation requires miles upon miles of hot-water piping that must be free from shutdown, for if the flow of water to the sulphur beds is interrupted the sulphur will cool or freeze and a new well must be drilled at considerable expense.

In districts where sulphur is mined in this way, such as in Southern Texas, the water is turbid, containing hardness which is likely to precipitate in the lines if heated without chemical treatment, as well as containing oxygen to the limit of saturation. Such a water, therefore, is unsuited in itself for the conditions desired and means must be used to prepare it free of incrusting solids and with qualities that will not corrode the distributing pipes. Fig. 1 illustrates the installation of what is believed to be the largest hot process lime and soda softener in the world, at the Texas Gulf Sulphur Company's plant at New Gulf, Texas. This plant has a total capacity of 420,000 gal. per hr. and delivers hot soft water free of dissolved oxygen. Approximately 25 per cent of the water delivered is used as boiler feed, and the remaining 75 per cent for mining operations after being heated to 320 F by 100-lb. steam from the boilers.

Note: The caption for the illustration on page 606 of the September installment of this article should read: "Deaerating heater with capacity of 50,000 g.p.h. at the Pilgrim State Hospital which protects brass hot-water piping from corrosion."



A striking view of an overhead steam line at the Tennessee Eastman Corporation plant.

Photo, Applied Photography

20-Story Building Humidified in Winter, Cooled in Summer

56-F Water from Deep Well . . . Two-Speed Motors Save Power . . . District Steam Used

By H. D. Nock*

The 20-story Mutual Home Building in Dayton, Ohio, which is entirely air conditioned. The first floor is utilized as banking space and the remainder as rentable office areas

Felt to be desirable because a building so equipped would enjoy a greater percentage of occupancy, an air-conditioning system was installed in the 20-story Mutual Home office and bank building in Dayton, Ohio. Results have been very satisfactory.

It was not expected that an air-conditioned building would derive more than a nominal increased rental value per sq. ft., so it was necessary to keep the cost of air-conditioning down. Several modifications were made from the ideal system, all such modifications being carefully considered so as not to impair the operation of the system. Availability of a supply of water from a deep well at 56 F aided installation of a low-cost system.

The air-conditioning system and its control, lay-out of the ducts, and the cost of power for winter and summer operation, are discussed in this article.

IN THE Mutual Home Building, Dayton, Ohio, is installed a heating and air conditioning system which is a departure from the conventional practice for office buildings, particularly for the rentable space on the upper floors.

The building is on a lot 80 ft. wide by 199 ft. long, and consists of seven floors the full size of the lot, and thirteen tower floors. It is of steel construction, fireproofed with concrete, with a reinforced-concrete floor system, and limestone exterior walls backed up with brick. Total content is 2,314,400 cu. ft. from the first to the 20th floors inclusive.

The first floor (including mezzanine at the rear) is utilized by the Mutual Home & Savings Association as a banking room. It contains about 14,000 sq. ft. of floor area, and has a content of 400,000 cu. ft. The 2nd floor comprises the space between the girders spanning the banking room; while this space is necessarily cut up by the constructional members, there remained space which could not be readily subdivided into offices, but could be available for other use. The building manager's office, the building work rooms, and storage space for building equipment and supplies are located on this floor. There is also some space which is utilized for office purposes. The heating on this floor is by means of direct cast-iron radiation located under the windows, controlled by thermostats and steam valves.

The 3rd to the 20th floors contain a total of approximately 80,000 sq. ft. of rentable floor space. The original construction program contemplated no interior partitions, it being more desirable to have

* Mechanical engineer for Schenck & Williams, Architects, Dayton, Ohio.

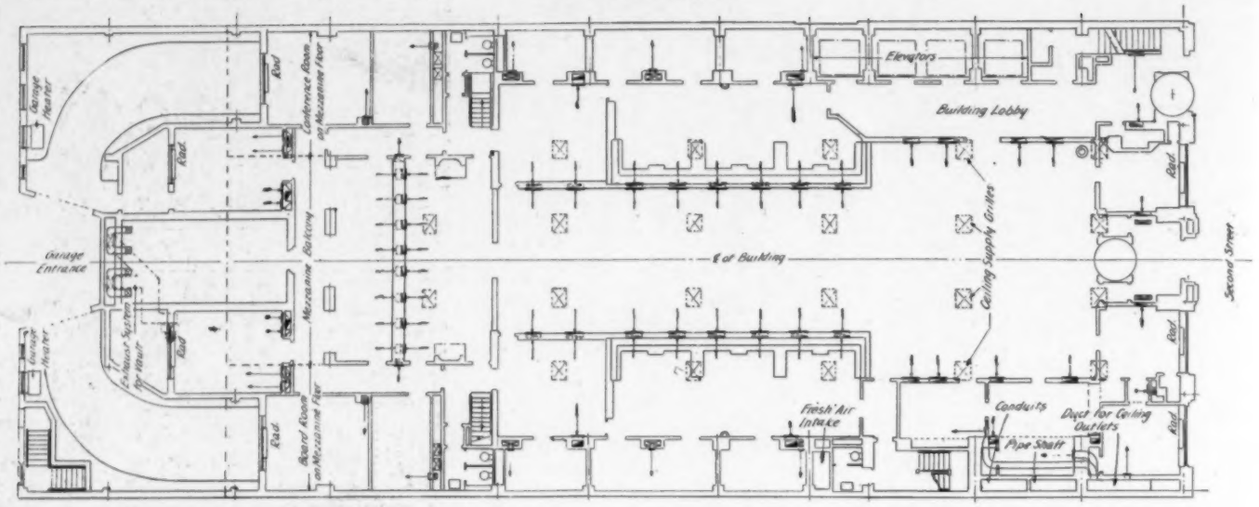


Fig. 1—Arrangement of the system for the main banking room. Note the overhead inlets and numerous returns. Behind the counters both inlets and returns are in walls and counters. Practically every nook has both supply and return so that both heating and cooling effects will be uniform

all partitions installed when the space was rented, to suit the requirements of the tenants.

In addition, there is a basement under the entire building and a sub-basement under approximately two-thirds of the building, which is devoted to tenant garage purposes and for housing the mechanical equipment of the banking portion of the building.

Steam Supplied from Street Mains

Steam is supplied from the distribution lines of the Dayton Power & Light Company; the steam line through the building is carried up a riser shaft. Above the 3rd floor, all apparatus requiring steam is located near this main riser shaft, occupying the center or unlighted portion of the floor space. Water heaters for the building and other apparatus which requires steam, are located in the basement or sub-basement of the building.

Air-Conditioning System Thought Desirable

At the time the building was being designed, careful studies were made by the architects and engineers with the idea of obtaining a comfortable range of temperature and humidity for both winter and summer for the banking space on the 1st floor and the office space on the 3rd to the 20th floors. A system of ventilation which would be readily adapted to the requirements of variable office layouts and which would lend itself to heating appeared desirable; in conjunction with the ventilating system, air conditioning which would provide for heating and humidity in the winter and for cooling and dehumidifying in the summer was considered to be advantageous. Such a system seemingly incorporated features which were felt to be desirable in a modern building.

First Cost and Operating Cost Considered Carefully

The capital or investment cost of the system, and the cost for operation both had to be carefully considered as it was not believed that a building in Dayton, equipped with an air-conditioning system, could be expected to derive more than a nominal increased rental value per sq. ft. of floor area over the rental received from unconditioned buildings. However, it was expected that such a building would enjoy a greater percentage of occupancy. In order to keep the investment cost down, several modifications were made from the ideal system, all such modifications being carefully considered so as not to impair the final operation. Ease of operation by the average building personnel was also kept in mind.

Well Water at 56 F Available

One of the main features in connection with the system, and which was a determining factor in the decision to use the air-conditioning system, was the availability of an adequate supply of well water having a temperature of approximately 56 F. This advantage is a local one and could not be applied in all cases.

Lay-out of the Duct System

In the layout of the system, special consideration was given to all duct runs, the location of outlets and the space required for apparatus in order to minimize the furring of ceilings, the maintenance of clear ceiling heights in all office spaces and the minimum changes or interference with other building construction. The air is introduced into the banking space through 22 large grilles located in the ceiling of the room; the ceiling height gives ample diffusion of the air before it reaches the living zone. In the smaller side rooms and private offices, wall grilles are used for the introduction of the air. The return air is taken back to the apparatus through grilles located in the base of the counters. Fresh air and return-air ducts are carried along the ceiling of the basement and up the side wall to the outlet grilles. See Fig. 1.

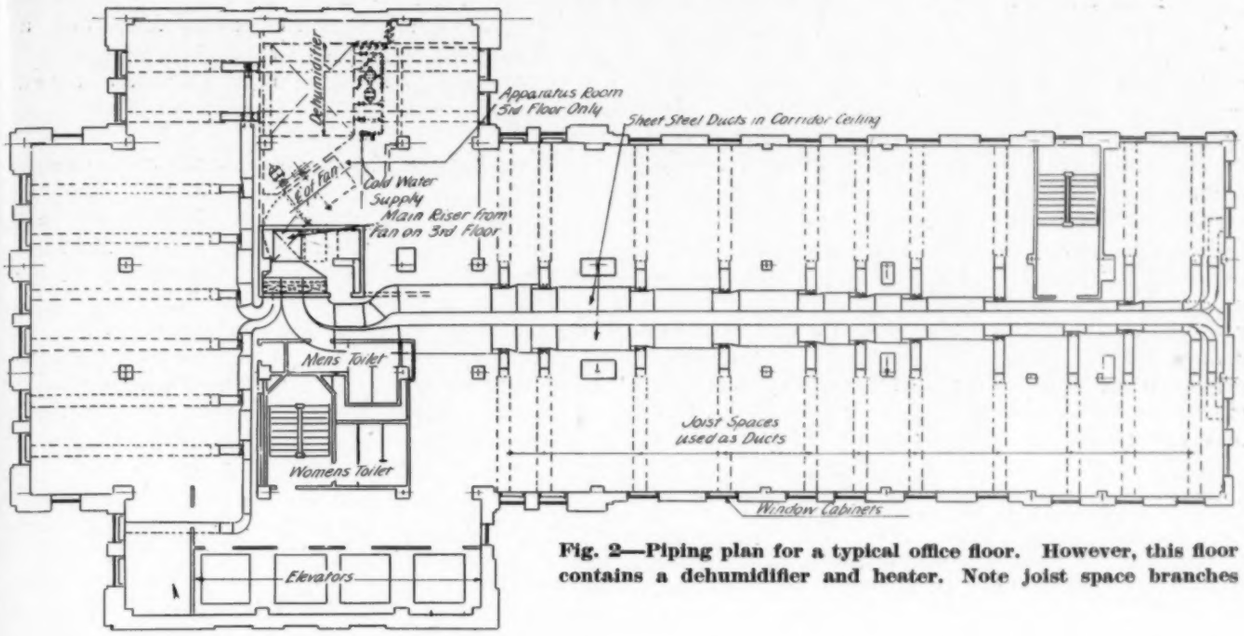


Fig. 2—Piping plan for a typical office floor. However, this floor contains a dehumidifier and heater. Note joist space branches

Two-Speed Motor Drives Fan

The air-conditioning apparatus for the banking space is located in the mechanical room in the sub-basement, and consists of a double-inlet type fan which is driven through a V-belt by a two-speed induction-type motor, the speeds being controlled by a manual throw-over switch. High-speed operation gives a fan delivery of 38,000 c. f. m. and the low-speed operation, 30,000 c. f. m. Other equipment comprises tempering and re-heating coils, a double-effect spray type dehumidifier, an air-washer pump and a water heater.

Temperature and Humidity Control

Proper temperature is maintained through a pilot thermostat located in the banking room, controlling a two-point thermostat located in the air discharge duct which in turn controls the valves on the heating surface supply. Proper humidity is maintained through thermostats on the dehumidifier with a change-over switch for the summer and winter thermostats which in turn control the proper water valves and the dampers. A reverse adjustable thermostat controls the volume damper in the fan outlet which in turn regulates the air volume, thereby maintaining the temperature for summer cooling.

Location of Apparatus

The 3rd to the 20th floors are divided into two systems, one serving the 3rd to the 7th inclusive, with the air-conditioning apparatus located on the 3rd, and the other system serving the 8th to the 20th, with the air-conditioning apparatus on the 8th floor. The two systems handle about the same amount of air and serve about the same sq. ft. area. In general, the same installation methods were followed in both systems, except where variations were necessary to take care of general building construction. The location of the apparatus is in space the least desirable for rental purposes; it was endeavored to arrange this space in such a manner as to permit of desirable office arrangements.

The air-conditioning unit on the 3rd floor consists of a single-inlet fan driven by a two-speed induction-type motor, the different speeds giving deliveries of 42,000 and 32,000 c. f. m.; a double-effect spray-type dehumidifier, air-washer pump and water heater. From these fans a main supply duct passes vertically up the central riser shaft to the upper floors where branches for each exposure are taken off for each floor. At each floor in the main branch taken off for the respective floor a heater coil with a by-pass around it was placed, with mixing dampers controlling the temperature of the air to the different sections of each floor.

Temperature control for winter use obviously could not be placed in each office and a compromise was adopted to control each different exposure; a mixing damper controlled by a thermostat was located in each duct serving the exposed side so controlled. Several outlets on each floor were provided for flexible location of thermostats. The steam valves on the heating coils are controlled by valves actuated by a thermostat in the hot air chamber.

Thermostat Controls Damper

Humidity control apparatus is located in the apparatus room on the 3rd floor; it consists of a summer and winter thermostat with a change-over switch operating the fresh and return air dampers and the water valves. A remote adjustable thermostat controls the volume damper at the fan outlet, maintaining the proper room temperatures.

Each Exposure Separately Controlled

The air distribution system for the 3rd to the 20th stories required careful study to attain the essential results and to effect all economies possible. The system of regulation required that each exposure of the respective floor be separately controlled in such a manner that a reasonably uniform temperature would prevail throughout this side of the floor. The distribution system also had to be designed to be of the most flexible character, as in a building of this kind devoted to rental offices, there are frequent and wide variations in office layout and various tenants' changes, into which changes the air-conditioning system must be fitted so as to give the maximum effect. It was considered expedient to effect economies in all places possible by the use of existing building constructional features for ducts, thereby limiting the quantity of sheet-metal duct work and minimizing furred ceilings which would tend to reduce the ceiling heights in office spaces and increase the building cost.

Central Riser Chamber for Ducts and Piping

A central riser chamber is provided in the center of the building in which are contained the supply duct from the fans, the heaters and mixing dampers for each floor and the various pipe lines serving the building facilities such as steam, return, water, etc. This chamber is also used as a return-air duct from the floors served by each unit to the apparatus intake, grilles being provided in the doors at the respective floors and through the floors of the riser chamber.

From the riser chamber, main branch ducts of galvanized sheet steel are carried along the corridor ceilings which are furred down to conceal the ducts. Each exposed side of the floor served has a separate duct with a mixing damper.

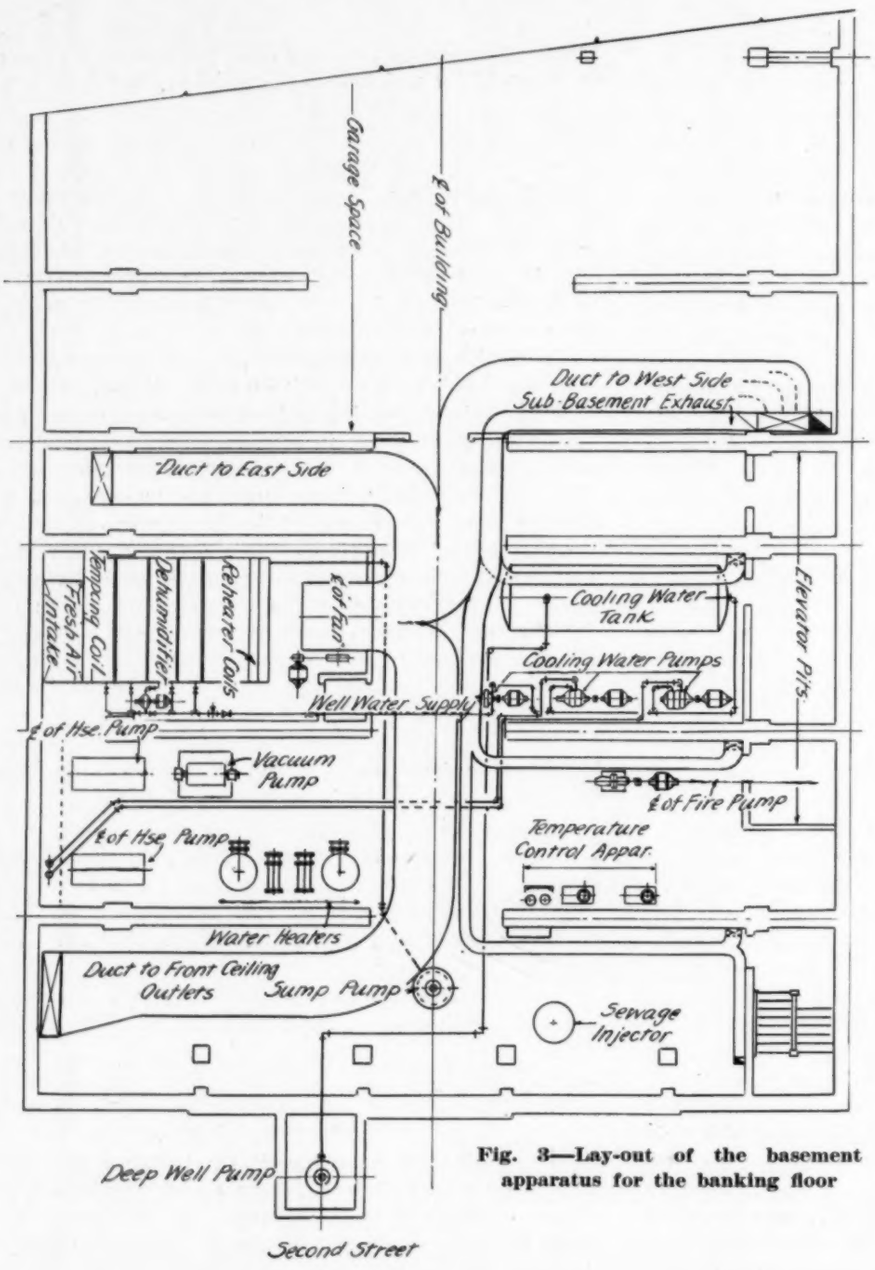


Fig. 3—Lay-out of the basement apparatus for the banking floor

Space Between Joists Used for Branch Ducts

The floor system was designed to utilize the space between joists for branch ducts from the main ducts to the various outlets under the windows. The branch for each window outlet is taken off from the main duct with a galvanized steel connection turned up into the joist space where a tight connection was made and all the spaces sealed airtight. Fig. 2 shows the general run of ducts and indicates where the window branches are taken off the joist spaces.

Outlet Cabinet at Each Window

At each window is placed a steel outlet cabinet built into and flush with the wall construction. This box is about sill height with a sloping grille over the top to prevent the opening being closed by the placing of books or other articles on it. A regulating damper operating by a quadrant from a handle on the outside of the cabinet enables the tenant to vary the quantity of air from no air de-

livery to wide open delivery, thereby giving him a control of the temperature in his office without affecting the temperature of the other offices. A volume damper is also provided for regulating the total quantity of air which may be delivered to any one outlet, which was fixed in place when the system was adjusted.

By the use of the joist spaces and outlet cabinet a clear ceiling has been maintained over the office space and it is possible to provide for wide variation in office arrangement without changing the system.

Return air passes out through grilles in the doors or corridor walls, using the corridor as a return duct, and down the main riser shaft to the air-conditioning unit. Excess air is taken off through the toilet room vents on each floor.

The 8th to the 20th floor system is of similar design and contains about the same apparatus and control.

Supply and Control of the Cold Water

The cold water system serving all air-conditioning apparatus is located in the sub-basement. A deep well was sunk in the sidewalk at the front of the building in which is a deep well pump discharging into a 7′-0″ dia. x 20′-0″ long 5,000-gal. tank. Water level in the tank is maintained by a float switch which controls the pump. From this tank a common suction line is carried to the cooling-water pumps located in the sub-basement and serving the three air-conditioning apparatuses. These pumps are motor-driven with manual switching equipment. The banking-room unit is a single-stage centrifugal pump, the 3rd floor unit is a 2-stage, and the 8th floor unit is a 3-stage centrifugal unit with a maximum capacity of 300 g. p. m. for the respective head required. From the pumps the water piping is carried direct to the air-conditioning apparatus rooms, where it is connected into the first two sprays of the dehumidifier, the remaining sprays being served by the dehumidifier pump which takes the water from the pan. Fig. 3 shows the tanks, pumps and connections.

Operation Has Been Satisfactory

The banking-room system has been in operation since last December and results have been very satisfactory. Temperature in the various parts of the room has been maintained within a few degrees of that desired at all times, and the relative humidity between the limits of comfort for the class of occupancy. Continuous operation of the system gives a much more uniform temperature curve than when the system is operated intermittently, as under intermittent operation it takes considerable time for the room to attain the proper temperature and humidity.

Cost of Winter and Summer Operation

The two-speed motor has proven a very desirable asset as the lower fan speed with the lower air volume has been ample for winter operation, which means a lower electrical input to the motor and a lower operating cost. The total motor hp. under low-speed operation (including fan motor and washer pump motor) is 24 hp. under maximum conditions. For summer operation with high speed on the fan motor, the washer pump motor, the cooling-water pump motor, and the proportion of the deep-well pump which should be allocated to the banking room equipment, the total is 61 hp. The operating cost for electric current at the average rate for the building is approximately $0.60 per hr. for winter operation, and $1.52 for summer. The cost for air conditioning for summer operation amounts to approximately $0.58 per hr. for maximum operating conditions over a regular ventilating system. Steam consumption has not been considered in these figures as it is assumed that it would have been practically the same in both cases, with the use of recirculated air.

The two systems on the upper floors have been in operation since November, but the final adjustments for air volume and control devices were not completed until about the middle of February. These two systems have not had the test the first floor system has had due to limited occupancy of the building, and the consequent necessity of conserving on operating costs. Occupied floors are carried at 70 F, and unoccupied floors at 50 F in winter, which does not permit operating the system to best advantage. As the building is now being occupied to a greater extent, the conditions of operation are being continually improved. Low-speed operation of the fans has proven more than adequate for the heating of the building, and as noted for the first floor, this materially reduces the operating costs.

The total motor hp. for low-speed operation for the 3rd- and 8th-floor units (including the fans and washer pumps) is 48 hp. and for summer operation with high speed on the fan motors, washer pumps and cooling water pumps and the proportion of the deep well pump which should be allocated to the upper floor systems, it is 136 hp. for maximum conditions.

The air-conditioning system was designed by the engineering department of Schenck & Williams (architects of the building) and installed under their supervision. Alvin H. Colbert, air conditioning engineer, collaborated with the architects in its design.

Simplified Practice Recommendation Accepted

The revised simplified practice recommendation R57-32 covering wrought-iron and wrought-steel pipe, valves and fittings has been accorded the required degree of support by the industry, and is to be effective from October 1, 1932, according to an announcement by the division of simplified practice of the Bureau of Standards.

This revision eliminates from the original recommendation the 3½ in. nominal inside diameter pipe from Table 3—"double extra-strong" pipe. The recommendation applies only to new installations and production of pipe.

The 2nd edition of the standard test code for disc and propeller fans, centrifugal fans and blowers containing amendments made in June, 1931, has been published by the *National Association of Fan Manufacturers.*

TROUBLE-SHOOTING

A Noisy Heating Job

By ..... William Goodman*

When concealed radiator supply branches become trapped, causing noise and vibration, the trouble is difficult to locate and to correct. Pipe is an excellent conductor of vibration, and sometimes the noise is heard with as much intensity in an innocent radiator as the one at fault. Trapped water in the heating system of a 16-story apartment building caused a terrific pounding every morning when the steam boilers were started. The testing outfit used successfully for locating the trouble, how the trouble was caused, and how it was corrected, are described here.

IN THE tenth-floor apartment of a tall apartment building, a terrific pounding obviously caused by trapped water occurred every morning when the boilers were started. When the complaint was first received, the radiator was set on ½-in. high pedestal legs, raising both the supply and return lines, a remedy which is usually successful. The next day the operating engineer was informed that the sound was still much in evidence, so the radiator was raised still further by setting it on 1-in. legs. This also failed to eliminate the noise, and the engineer was told so in no uncertain terms.

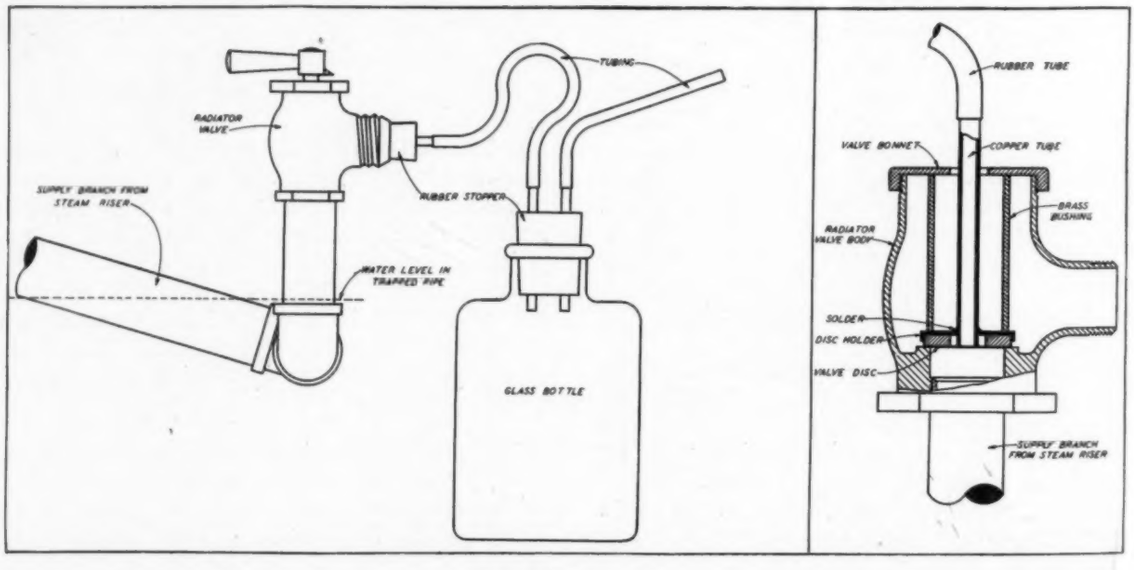
The supply pipe is concealed in a chase in the wall and could not be raised any higher because it was touching the top of the chase. Reluctantly, a decision was reached to break into the wall. The opening was to be started at the point where the radiator supply pipe came through the wall, and was to be continued, back to the riser if need be, to find the trapped portion of the supply line.

The wall was cut and the entire pipe exposed back to the riser without disclosing any trap. The pipe had a good pitch back to the riser and everything was as it should be. In order to make sure that there was no obstruction inside the supply pipe, it was removed and examined. The pipe was clear except for a little scale. The tenant was insistent that the sound came from his radiator. To test this the supply line was replaced but the wall was left open. The radiator valve was shut off. Slowly the main valve on the riser was opened, and there ensued the customary vigorous pounding. The blows of the rhythmic pounding could be plainly felt by touching either the riser or the supply branch. They could also be felt, but more faintly, by touching the return riser and branch.

*Consulting engineer, Chicago, Ill.

Fig. 1 (Left)—Testing outfit for locating trapped radiator supply lines. If a slight vacuum is pulled on the bottle, the trapped water is lifted into it

Fig. 2 (Right)—Special fitting made from spare valve to eliminate need of disconnecting radiator valve each time test is made



The sound was not being produced in the supply line to this radiator as it was properly pitched and clear inside. However, this same steam riser supplies two radiators on each floor, one in the bedroom and the other in the dining room. Inasmuch as the pounding was felt very plainly by touching the cross on the riser, it was felt that possibly the supply branch to the dining room radiator was trapped.

Legs were installed under the dining-room radiator in the hope that it would be unnecessary to open the wall, but with no success. The wall was then opened and the supply line exposed to the riser. Examination showed it to be clear.

Fig. 3 — Testing outfit ready for test

It was now obvious that the noise was not being produced in either of these two radiators. When this was suggested, not only did the tenant ridicule the idea, but the building engineer as well. To convince both tenant and engineer, the supply piping to the dining-room radiator was not replaced. The supply piping to the bedroom radiator was again removed and the two outlets in the riser cross plugged. The main steam valve on the riser was again slowly opened and again the same vigorous banging was heard. This was a sufficiently convincing demonstration that the trouble was not caused by the radiators in this apartment.

As this is a 16-story building and there are thirty radiators in fifteen apartments supplied by this one steam riser, it meant that the trouble might be in any one of the remaining 28 radiators. Obviously the walls in all 28 rooms or even a fair proportion of them could not be opened in order to discover the guilty supply line. Cautious questioning of all the tenants failed to elicit any information.

To meet this difficulty, a simple method of testing these radiators was devised. If a radiator supply line is trapped, by disconnecting the radiator valve and pulling a slight vacuum through it, the trapped water should be lifted back into the room; the apparatus shown in Fig. 1 was assembled for this purpose. Before testing a radiator supply branch the main riser valve should be closed and the riser and all the radiators it supplies should be allowed to cool off. The radiator valve should be disconnected and opened wide to allow the riser to fill with air. When the riser is at atmospheric pressure, the test can be made. In order to be sure that the trapped supply branch is full of water, some water should be poured into the supply pipe. If the supply pipe is properly pitched, all the water will drain back into the riser. However, if the supply pipe is trapped, some of the water will remain in the branch.

A small hand-operated pump, very much like a tire pump in appearance and construction, was used to pull the necessary vacuum. Every time water was poured down a trapped supply line we were able to pull it back. Erratic results were obtained when we endeavored to use "lung power," instead of the pump, to create the vacuum.

To eliminate the necessity of disconnecting the radiator valve each time a test was made and to make the filling of the supply pipe with water an easier matter, a special fitting (illustrated in Fig. 2) was made from parts of a spare valve. With this fitting, all that it is necessary to do is to remove the working parts of the valve by simply unscrewing the valve bonnet. The valve body to which the pipes are connected is left in place. The special fitting was made from the bonnet, disc and disc holder of another valve. The bushing was made from a piece of brass pipe. By inserting this fitting into the valve and tightening the bonnet, the bushing forces the disc against the valve seat and makes a tight connection. Also, since the radiator valve is left in a vertical position, all that one has to do to fill the supply pipe with water is to insert a funnel, after removing the valve element. The entire testing outfit installed and ready for a test is shown in Fig. 3.

The following testing procedure was outlined:

Turn off the main valve controlling admission of steam to the riser.

Remove the valve element from the radiator supply valve.

RISER DIAGRAM

FLOOR	DINING ROOM	BED ROOM
16	✓	✓
15	✓	✓
14	TRAPPED	✓
13	✓	✓
12	TRAPPED	✓
11	TRAPPED	TRAPPED
10	✓	✓
9	✓	✓
8	TRAPPED	✓
7	TRAPPED	✓
6	✓	✓
5	✓	TRAPPED
4	✓	✓
3	✓	✓
2	✓	✓

Fig. 4—Diagram showing location of radiators which were found to be trapped

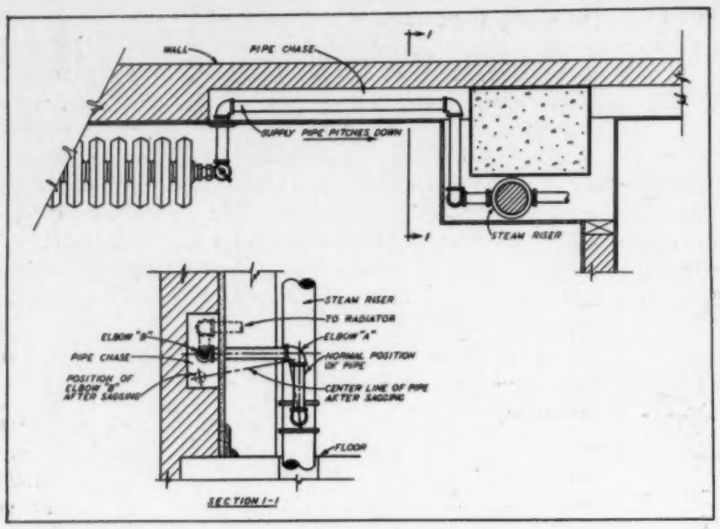


Fig. 5—How the trouble was caused. Movement of the riser caused the elbow "B" to rest on the bottom of the chase. Had the elbow "A" been installed so that it lined up with the bottom of the pipe chase, no trap would have been formed when "B" sank

Wait until the riser ceases to pull air; that is, until its vacuum has been completely destroyed.

Insert the funnel into the valve and pour a pint of water into the pipe.

Remove the funnel.

Insert the special fitting in the body of the radiator supply valve and tighten the bonnet.

Try a half-dozen strokes on the vacuum pump. If the supply line is trapped, this will be sufficient to cause the water to pour back into the bottle.

Each of the thirty radiators on this riser were tested. The original two were tested out of curiosity and gave a negative test—that is no trap. Of the other radiators tested, seven were found to be trapped, as shown in Fig. 4.

The building engineer was very much puzzled as to why no complaints had been received from other tenants. An examination of Fig. 4 will clarify the following explanation:

The 8th and 14th floors are vacant. The trapped radiators on the 7th and 12th floors are in dining rooms, while the adjoining bedrooms are used as guest rooms. On the 11th floor where two radiators were trapped, one was in the dining room, while the bedroom was used as a "den." As for the tenants on the 5th floor, they must have been exceptionally heavy sleepers. In all of these rooms, with the exception of the 5th floor bedroom, the noise is very rarely apt to be heard at 5:30 a. m. Even so, it seems that some one of these tenants must have heard the noise and at one time or another made a complaint.

Of the seven trapped radiators, we were able to correct only two by setting them up on 1-in. high pedestal legs. It was necessary to cut open the walls clear back to the riser in order to eliminate the water traps in the remaining five radiators. Fortunately, this testing outfit can be used after repairs have been made, to make sure that the trouble has been corrected. No more does the repair man simply raise the radiator and leave the job with the uncertainty as to whether or not the trouble has been corrected.

The cause of this trouble is illustrated in Fig. 5. The elbows *A* and *B* were installed about 3 in. above the bottom of the pipe chase. Due to the movement of the riser, the elbow *B* sank until it rested on the bottom of the chase. The elbow *A* maintained its position, and the radiator end of the supply pipe was held in place by the radiator connection. As a result, a trap was formed. Had the elbow *A* been installed about 3 in. lower so that it lined up with the bottom of the pipe chase, there would have been no trap even when elbow *B* sank. This installation is obviously a source of further trouble and it is quite possible that trapped supply branches will appear on this riser in the future.

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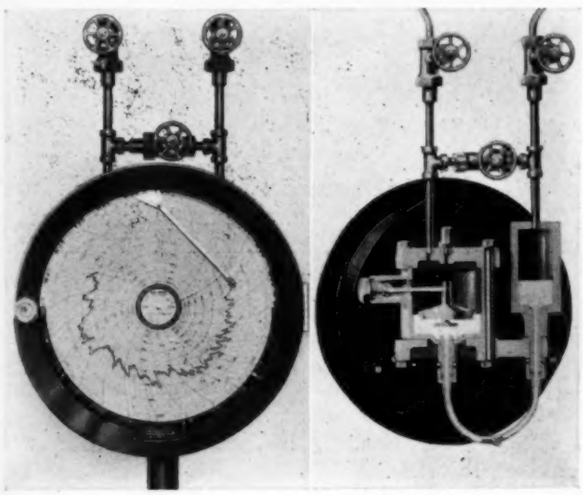
INTERESTING Equipment..... Developments

A NEW line of mechanical flow meters developed by the Brown Instrument Company, Philadelphia, Pa., is featured by a simple direct lever-actuating mechanism, a powerful float, a pressure-tight bearing with grease reservoir, a series of range tubes that permit changing the range of the meter without disturbing the orifice, and a type of construction and assembly whereby the manometer may be taken apart and cleaned in the field without altering the calibration. This meter has

been developed in a number of combinations, including: square root and evenly-divided charts; automatic planimeter; multipen—flow—pressure—temperature; compensation for pressure and temperature; automatic control and recording.

The model illustrated is representative of the entire line. The instrument mechanism is built into a die-cast aluminum case attached to the manometer assembly by a three-armed bracket that also supports the high- and low-pressure chambers of the manometer; the high-pressure chamber is a drawn steel cup



and the low-pressure chamber or range tube is seamless steel tubing, the two being connected by the steel U-tube shown. The U-tube has a drain plug at its lowest point for convenience in withdrawing the mercury from the manometer.

The high-pressure chamber is sealed on top by a gasket set in a recess in the cover and drawn against a double groove in the top edge of the high-pressure chamber by five bolts. A forged steel tee-fitting welded to the side of the high-pressure chamber provides a means for mounting the pressure-tight bearing in a position for attaching the float lever on one end and the pen on the other end.

The calibration is fixed by the construction of the meter because the relative positions of the float and pen linkages are fixed by flats on the pressure shaft and the lengths of the links. It is thus possible to drain the mercury from the manometer, open and clean it, reassemble it, and add enough mercury to bring the pen to zero, without changing calibration.

The changeable range tubes facilitate shifting a meter from one job to another without disturbing existing orifice conditions. Mounting means are provided so that any model may be mounted on a floor stand, wall bracket, or pipe saddle; die-cast case permits flush mounting on a panel.

Weight of the instrument has been reduced as far as is consistent with a working pressure of 1,000 lb.; it is portable in the sense that it can be carried from one job to another.

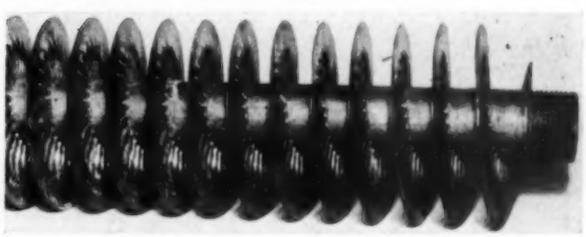
New Finned Pipe

McCORD RADIATOR & MFG. CO., Detroit, Mich., have developed a method of applying a continuous copper or steel fin to galvanized iron, steel or copper pipe in ¾, 1 and 1¼-in. pipe sizes. Such pipe is particularly adapted to use in concealed radiation. It is also used in the refrigeration industry, in cold storage warehouses, ice cream plants and refrigerator trucks.

The following widths of fin are supplied: 1″ with ¾″ pipe, 1¼″ with 1″ pipe, and 1½″ with 1¼″ pipe. Varied fin spacings are available, ¼″, 1/3″, ½″ and ¾″ in copper fin, and in steel fin ½″ and ¾″. Pipe is supplied in standard lengths up to 20 ft.

The fins are wound on the pipe by stretching the outer portion of the ribbon. By this method the fin is applied to the pipe under high pressure to insure good metal-to-metal contact, made permanent by a further tinning or galvanizing operation. Greater lineal foot contact is obtained by the base of the fin being slightly corrugated and thicker than the outside edge. The copper fins are tinned, while steel fins are either tinned or galvanized as specified.

Laboratory tests of 1¼″ plain galvanized pipe compared with 1¼″ fin pipe, using 1½″ copper fins, spaced ¾″, showed 1 ft. of fin pipe to have the same capacity as 3 ft. of plain pipe. Changing the fin spacing to ½″ increased the capacity of the fin pipe to four times that of the same length of plain pipe. A further change in fin spacing to ¼″ increased the capacity to seven times that of the length of plain pipe.

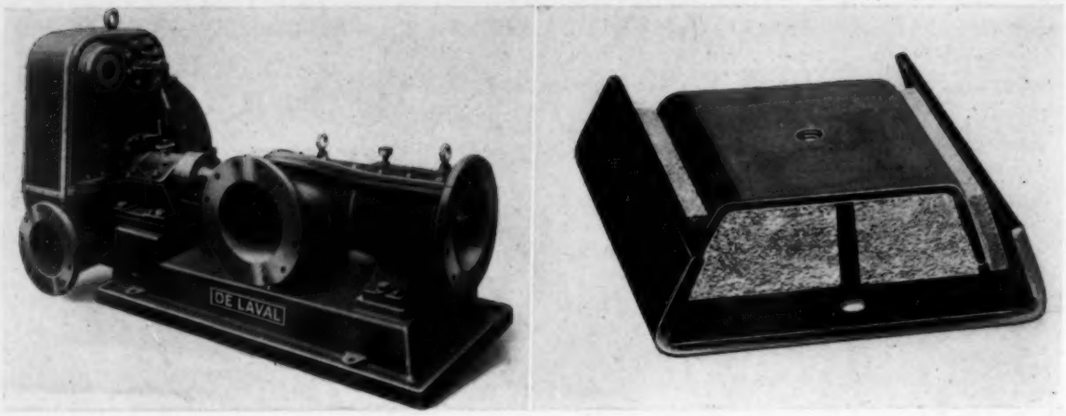


Pump Handles Large Volumes

FOR handling large volumes of liquid against comparatively low heads, the propeller pump shown on the next page has been developed. It is built for both horizontal and vertical installation and is available for all capacities and for heads up to about 40 ft. It is suitable for direct connection to a standard speed electric motor or steam turbine, or a speed-reducing gear may be used, according to conditions.

The design is such that the liquid flows through the pump in smooth lines, without abrupt turns or changes in direction; when liquid enters and leaves a pump without turbulence or shock, efficiency is improved.

The pump casing consist of two parts separated in the plane of the center line of the shaft by a flat joint and maintained air and water tight by a thin paper gasket;



the cover can be lifted off to render the interior parts accessible. The propeller is designed for the specified conditions of capacity, head and speed, and is finished on all surfaces, the blades being filed and scraped to templates to insure the shape required by hydraulic design. The casing around the propeller is protected by a separate sleeve, which can be renewed should wear occur, which supports the guide vanes by which the liquid is directed in smooth flow-lines. The shaft is protected from wear by a removable sleeve which extends through the stuffing box and provides a bearing surface for the packing.

At the coupling end the shaft is supported by a grease-lubricated ball-bearing with a separate ball thrust bearing in the same housing. At the propeller end, the shaft is supported by a bearing of the sleeve type. The stuffing box is designed for soft packing, with a lantern ring to facilitate water sealing where desired. The gland is split and can be removed without disturbing the other parts.

The manufacturer is the De Laval Steam Turbine Company, Trenton, N. J.

For Checking Temperatures

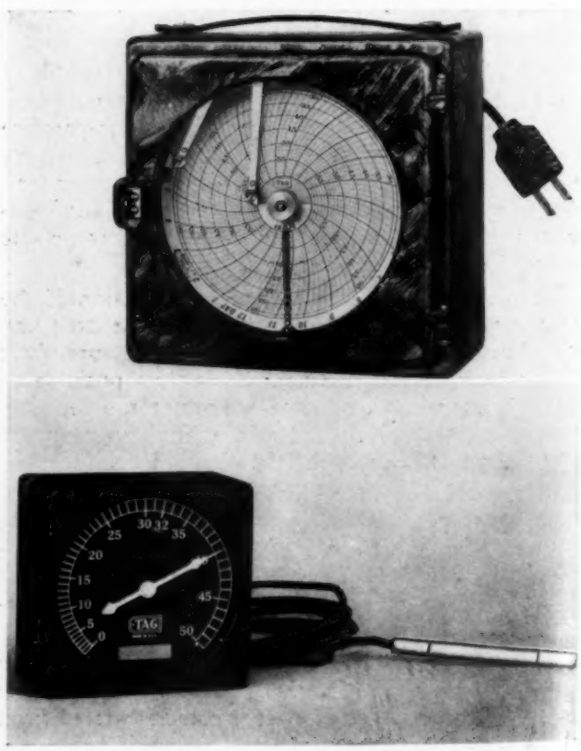
IN checking the operation of air-conditioning, heating and refrigeration equipment a record of temperature or temperature and time operation is usually necessary. The miniature-size recording thermometer recently announced by C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y., was developed for such purposes. The record is made on a chart 4⅝ in. in diameter; weight of the instrument is about 3½ lb. Expansion or contraction of the vapor in the bulb and tubing actuates a bellows and the motion is transmitted directly to the pen arm. Ranges are 30 to 130 F, and —10 to 40 F, 30 to 60 F, and 50 to 90 F.

For indicating temperatures in refrigeration work, the square-case dial-indicating thermometer illustrated may be used; it is available in two ranges—0 to 50 F and —20 to 40 F. The mechanism is enclosed in a black case 4 in. by 4 in. by 2½ in. and the weight is about 1¾ lb. The dial is 3½ in. in diameter.

Isolates Vibration

FOR isolation of vibration and noise from small refrigerating machines, air conditioning units, fans and blowers, motors, etc., The Korfund Co., 48-15 32nd St., Long Island City, N. Y., has developed the damper illustrated above. The isolating material (natural cork or other resilient material) is placed between an upper and lower housing, and is pre-loaded at the factory at the proper point to compensate for the loading established by the machine and the peak efficiency loading required by the isolating material. Each damper is assembled to order.

The upper housing is drilled and tapped to permit bolting to the machine base or leg and the lower housing is drilled for two ⅜-in. bolts for anchoring to the floor. The maximum load for each damper is 400 lb.



Industrial Switch Line Completed

AN ADDITION to the line of industrial switches made by the Trumbull Electric Mfg. Co., Plainville, Conn., has been announced. The new sizes are 30, 400, 600 and 800 amp., making available a complete

line from 30 to 800 amp. inclusive, 2, 3 and 4-pole, 230 and 575 volts a.c., side and front operated.

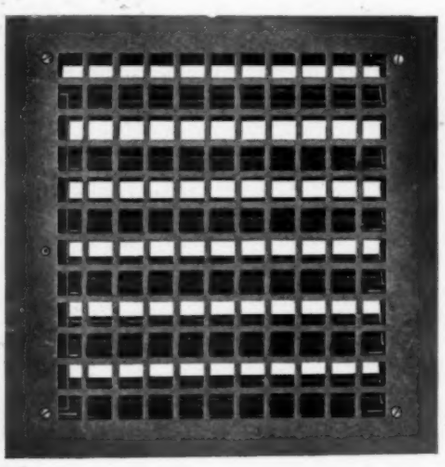
Features of these switches are a vise-type fuse clamp which reduces heating at the fuse terminals and a type of roll contact designed to maintain perfect line contact under heavy pressure. The roll changes in position with each operation, making it self-wiping.

The arc is broken from extended tips of stationary contacts to the inside of sliding contacts, in such manner as not to affect current-carrying surfaces.

Registers Control Air Flow

A NEW key-operated register for heating, ventilating and air conditioning systems is designed to improve flexibility and control of such systems and facilitate their balance. Provided the system is designed for equal resistance, tests have shown that the volume of air may be varied from zero to 100 per cent of normal by turning the key. It is designed to eliminate the need of volume control dampers, elbow diffusers, etc. Its appearance is that of a grille.

Of heavy construction, the register box is made of No. 16 gage steel and on sizes up to 14 x 14 the face is of No. 12 gage stock; on larger sizes No. 10 gage is used. The manufacturer is Wm. Highton & Sons, Division of Hart & Cooley Mfg. Co., New Britain, Conn.



Announces New Welding Rods

ANNOUNCEMENT of a line of general-purpose welding rods comes from The Champion Rivet Company of Cleveland, Ohio. Featured is a heavy flux-coated rod to produce welds from 60,000 to 70,000 lb. tensile strength with an elongation in excess of 35 per cent in 2 in. A general-purpose rod with a powder coating and two types of light-coated rods for special applications—over-head and vertical welding, for instance—have also been announced.

An automatic device also being introduced is a structure consisting of arms extending from a bus bar so arranged that as current passes through the arms the electrode which has been attached to the work consumes itself without effort on the part of the operator; this device is said to be particularly applicable to welding of storage tanks and pressure vessels where longitudinal seams are prominent.

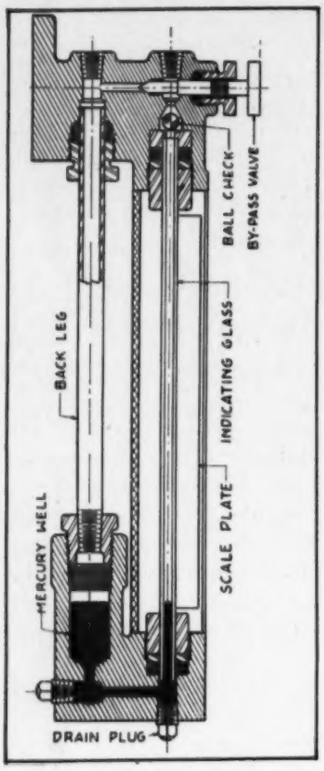
Control Has Commutator-Type Contacts

USE of commutator-type contacts is a feature of a new electrically-operated control instrument developed recently by the Foxboro Company of Foxboro, Mass. This device is used to control temperature, pressure, humidity, flow, or liquid level and to give audible or visible signals. It is designed to operate valves, compressors, blowers, motors, heating units, etc. It has a wide variety of industrial applications.

The instrument is so designed that it is possible to use a lockup type of relay in the circuit; the contacts carry only the relay load. Flexibility of design permits various combinations of commutators so that special signalling or control problems may be met; a special time cycle feature can be added.

The commutator-type contacts are designed to give accurate control, allow uninterrupted pen travel, and give positive all-time contact with a minimum of arcing.

Indicating-Type Flow Meter



DEVELOPED for use in industrial pipe lines where metering is necessary but where cost must be a minimum are the indicating-type flow meters made by Morey & Jones, Ltd., 922 S. Hemlock St., Los Angeles, Calif. Features include a built-in by-pass or cross-over valve for checking zero level of the mercury column and eliminating entrapped air collected during operation.

Briefly, the instrument is a modified U-tube consisting of a mercury well and indicating glass. Mercury rises in the calibrated glass due to difference in pressure existing on each side of an orifice plate placed in the pipe line. Three standard scale plates may be furnished 6, 12 or 18 in. long. Special orifice flanges simplify installation of the orifice plate.

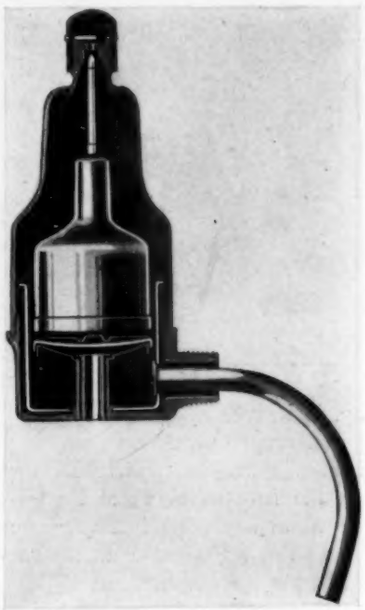
The instrument can be used for indicating rate of flow of water, oils, syrups, steam, air, gases, etc., in any desired units. It also has applications in checking important recording flow meters, indicating liquid level in pressure tanks, etc.

Line-Starters Are Explosion-Resisting

A NEW line of explosion-resisting line starters has been announced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. They have been developed for use in Class I, Group D, hazardous locations as described in Article No. 32 of the National Electric Code, (i.e., they are designed for use in locations where highly flammable volatile liquids or gases are manufactured, used or handled, particularly designed for use around oil refineries, dye plants, chemical plants, gasoline stations and similar locations.)

The starters consist of standard units mounted in heavy cast-iron cabinets with wide flanges in accordance with Underwriters' specifications. Such features as a de-ion contactor, and combination hand and automatic reset thermal overload relay are incorporated. They are built both with separate mounted push button and with built-in push button. Explosion-resisting push buttons for two-wire control (low voltage release) and for three-wire control (low voltage protection) are available.

New Vacuum Valve



A NEW vacuum valve for installation on radiators in one-pipe steam-heating systems is announced by the Hoffman Specialty Co., Inc., Waterbury, Conn. A double vacuum air lock is a feature of this valve; the vacuum check at the top acts as the vacuum starter in a half-hot radiator; the vacuum diaphragm is the main lock that closes the port, exerting a pressure 20 times greater than the check.

The valve is of all metal, double shell construction; base and nipple connection are a one-piece, hot brass forging; the valve pin is of non-corrosive nickel silver. Maximum operating pressure is 10 lb.; the connection ⅛ in.

Controls Humidity

THE instrument shown here has been developed for close control of humidity and may be applied to humidification or dehumidification equipment. It is set at the relative humidity which it is desired to maintain by an adjusting screw.

An especially - prepared hygroscopic ribbon element expands or contracts as the moisture content of the air brought in contact with it changes; this element is unaffected by the dry-bulb temperature. The small amount of expansion or contraction is multiplied by a lever mechanism used to operate a sealed mercury tube switch. The ribbon is protected by a tension release spring should the relative humidity exceed 70 per cent. The manufacturer is Lewis Air Conditioners, Inc., 829 Second Ave. South, Minneapolis, Minn.

Recent Trade Literature

Alloy Pipe: The Babcock & Wilcox Tube Company, Beaver Falls, Pa.; 16-page engineering treatise on four- to six-per cent chromium steel tubes and pipe.

Belting: Graton & Knight Company, Worcester, Mass.; 12-page booklet containing leather belt rating tables and information on selecting belts for power transmission.

Boilers and Steam Plant Equipment: The Babcock & Wilcox Company, 85 Liberty St., New York City; 40-page condensed catalog of boilers, burners, tubes and pipe, special process equipment, etc.

Boiler Feeders: Bundy Steam Trap Company, Nashua, N. H.; eight-page bulletin describing three-valve boiler feeders and outlining the advantages of their use.

Check Valves: Bundy Steam Trap Company, Nashua, N. H.; four-page bulletin describing check valve for 0 to 275 lb. working pressures, sizes ½ to 3 in.

Equalizing Valves: Gorton Heating Corp., Cranford, N. J.; four-page pamphlet describing equalizing valves and air eliminators for steam heating systems.

Fans: Myers Electric Company, 425 Fourth Ave., Pittsburgh, Pa.; folder describing propeller-type ventilating fans of all-steel welded construction; standard sizes are 12 to 48 in.

Heaters: The Griscom-Russell Company, 285 Madison Ave., New York City; data sheet on storage-tank oil heaters for heating oil to be withdrawn from various types of oil tanks.

Hot Water Supply: American Gas Products Corporation, 40 W. 40th St., New York City; 28-page hot water supply manual designed to simplify the selection of gas-boiler equipment for large-volume water heating.

Meters: Builders Iron Foundry, Providence, R. I.; 12-page bulletin describing in detail wide-range electric fluid meters using a telechron-driven contact device and a telechron-driven chart pen and integrating counter.

Motors: The Lincoln Electric Company, Cleveland, Ohio; four-page bulletin describing totally-enclosed, fan-cooled, induction motors of stainless steel for use where there is dust or dirt, moisture, fumes, etc. Heat is transmitted by air sealed within the motor to a corrugated stainless-steel radiating surface where it is transmitted to outside air drawn through the motor cover.

Oil-Burning Equipment: York-Lalor (Division), York Oil Burner Co., Inc., York, Pa.; folder describing automatic shut-off valves for stopping flow of oil in case of pipe or fitting breakage or the over-feeding of oil at burners. The valves may be applied to protect the piping of an entire system, a group of burners, or one burner.

Pipe: The Youngstown Sheet & Tube Co., Youngstown, Ohio; 26-page booklet describing briefly the products of this company, including pipe, tubing, sheets, plates, forged steel unions, etc.

Radiator Enclosures: American Radiator Company, 40 W. 40th St., New York City; 28-page bulletin presenting engineering and dimensional information on radiator enclosures; installation details are shown.

Regulators: Defender Automatic Regulator Co., St. Louis, Mo.; four-page pamphlet describing in detail two electric furnace-draft regulators, an electric damper regulator and an elecric motor-operated temperature regulator.

Stainless Steel Sheets: American Sheet and Tin Plate Company, Frick Building, Pittsburgh, Pa.; 24-page booklet describing various types of stainless-steel sheets and light plates, outlining their uses and containing notes on the selection of the proper alloy.

Steam Traps: Bundy Steam Trap Company, Nashua, N. H.; data sheet for thermostatic steam trap with mechanical operation of inverted-bucket type, pipe sizes ½, ¾ and 1 in.; four-page folder describing steam traps, pipe sizes ¾ to 2 in.; also, four-page folder on pumping traps for handling condensate.

Stokers: Modern Coal Burner Company, 3733 Lincoln Ave., Chicago, Ill.; 16-page pamphlet describing the construction features of an underfeed stoker and discussing the principles of stoker firing and the features to be considered in stoker selection.

Superheaters: The Superheater Company, 60 E. 42nd St., New York City; 16-page booklet illustrating and describing various installations of multiple-loop, single-pass superheaters.

Welded Tube: The Carpenter Steel Company, 100 Broadway, New York City; folder containing general information, physical properties and working instructions for stainless welded tubing made from cold-rolled stainless strip steel; information on expanding and Van Stoning, welding, bending, etc., is included.

Welding Wrought Iron: A. M. Byers Company, Clark Building, Pittsburgh, Pa.; four-page folder giving practical information on welding wrought iron and engineering data on the properties and characteristics of wrought iron.

Conventions and Expositions

American Welding Society: Fall meeting, Oct. 3-7, Hotel Statler, Buffalo, N. Y. Secretary, Wm. Spraragan, 29 W. 39th St., New York City.

National Association of Practical Refrigerating Engineers: Annual convention, Sherman Hotel, Chicago, Ill., Nov. 1-4. Secretary, Edward H. Fox, 435 N. Waller Ave., Chicago.

American Society of Mechanical Engineers: Annual meeting, Dec. 5-9, New York City. Secretary, Calvin W. Rice, 33 W. 39th St., New York City.

National Power Show: At Grand Central Palace, Dec. 5-10, New York City. Managers, Charles F. Roth and Fred W. Payne, International Exposition Co., Grand Central Palace, New York City.

American Society of Refrigerating Engineers: Annual meeting, New York City, Dec. 7-10. Secretary, David L. Fiske, 37 W. 39th St., New York City.

American Society of Heating and Ventilating Engineers: Annual meeting, Jan. 23-25, Hotel Gibson, Cincinnati, Ohio. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

Heating · Piping and Air Conditioning

EDITORIAL

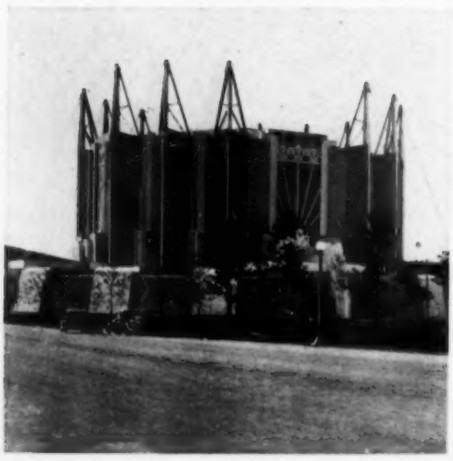
"Tomorrow is here, prepare for the present," says A. W. Robertson, head of a national committee on rehabilitation. "A new period of building activity is upon us," say two thousand architects whose reports have been analyzed. "A new era in building is dawning," prophesies Chicago's Century of Progress, through such buildings as its Travel and Transport Building, illustrated here.

This journal has published many editorials carrying the message "Prepare for tomorrow." They are now being commended by those who applied the suggestion.

But the job is not yet done. Some have not prepared for tomorrow. "They do not realize," says the committee on rehabilitation, "that the surplus capacity in American industry in 1929 has been wiped out by depreciation and obsolescence. They do not realize that this is a time of opportunity for the buyer of equipment and manufacturer as well."

So a large part of the job of the rehabilitation committee consists in doing just what these editorials have been doing for many months—pointing out the advantages of prompt replacement or repair of ineffective equipment.

In some organizations, conditions are such that make it impossible to go ahead immediately with desirable or necessary replacement or repair of heating, piping and air conditioning systems. However, it seems desirable that the plans for such work be carefully thought out and put down on paper now for immediate use when they can no longer be put off or when the money to go ahead with them is available.



This point brings to mind a consultant on interior decorating for a large department store who has made a job for himself in remodelling its facilities. A few inexpensive changes in one department immediately increased sales and are quickly being paid for. A more elaborate program of modernization designed to accomplish the same result for the store's restaurant is postponed until the money becomes available, but he has the plans on paper ready to shoot when the right time comes.

The same principle applied to heating, piping and air conditioning equipment in plants and buildings should prove equally sound.

Heating · Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

OCTOBER 1932

Material in this Section prepared by Publication Committee: F. D. Mensing, *Chairman;* E. O. Eastwood and F. E. Giesecke
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Air Supply, Distribution and Exhaust Systems

By S. R. Lewis*, Chicago, Ill.
MEMBER

NO MATTER how efficient may be the preparation of the air exterior to a room, the heating, ventilating or air conditioning plant is likely to be condemned unless the air distribution within the room is effective. Arrangements which have proved satisfactory for heating, often fail when used for cooling. While for small and old rooms it is customary and expedient to install portable cooling units, independent of the built-in heating and ventilating apparatus, there is no reason why all newly-designed heating and ventilating apparatus should not be adapted equally well to cooling and ventilating.

For the purposes of this paper, rooms in which air is used to supply or to remove heat and moisture are classified roughly as follows:

1. Residence and other comparatively small rooms; indirect warm air heating and/or conditioning system.
2. Residence and other comparatively small rooms; principal heating accomplished by direct radiators or convectors.
3. School building classrooms.
4. Theaters.
5. Rooms of large area but low head room, such as general offices, manufacturing rooms, etc.

Residence and Other Small Rooms

Under this heading are treated comparatively small rooms where the heating is accomplished (1) by a warm air heating and/or conditioning system (Class 1), and (2) by direct radiators or convectors (Class 2).

Heating by Warm Air System (Class 1)

It has been the practice with gravity circulation, to place the supply registers in the floor or in the baseboard at the floor, and to place the return grille in the floor of the first story. When mechanical circulation was introduced, any change in register locations met with considerable resistance.

One radical innovation was to extend the supply ducts to the outside walls and then upward in these walls so as to discharge the air horizontally into the rooms at about knee height, under the center of each major-sized window. This was not entirely satisfactory as the occupants noticed the air currents. Furthermore, the riser in the outside wall was difficult properly to insulate and this location of the intake accentuated rather than alleviated down-drafts from the windows. The return air grilles with this arrangement of supply registers were placed at a central point, say in the hall, at or near the floor, or individual return grilles from each room were provided, usually at the side of the room opposite the supply register. While these arrangements operated more or less effectively for heating (Fig. 1), they were not satisfactory for cooling (Fig. 2). If cool air is introduced at one side of the room at the floor, and if the escape opening for the heated air to be displaced by the cool air is at the floor at the other side, the cool air will travel across the floor and will escape through the vent or return air opening, and will fail to affect the over-heated air in the upper part of the room to any perceptible extent.

Based on present available information, it appears that the air supply opening will serve satisfactorily if located high on an interior wall, looking toward the exposed wall, and that this location answers well also for gravity indirect heating. The return air arrangements corresponding to this apparently are not subject to exact rules, but must be adapted to circumstances. For instance, where the building is compact, with a first story having rooms open to each other, a single, centrally-located re-

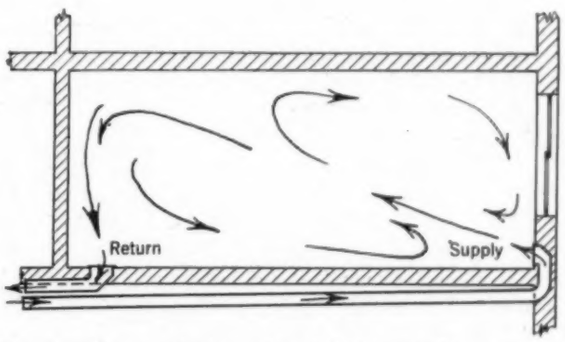


Fig. 1—Air circulation when heating with low-supply and return openings

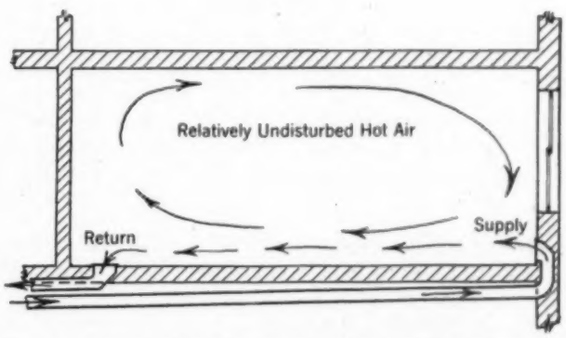


Fig. 2—Air circulation when cooling with low-supply and return openings

*Consulting engineer.

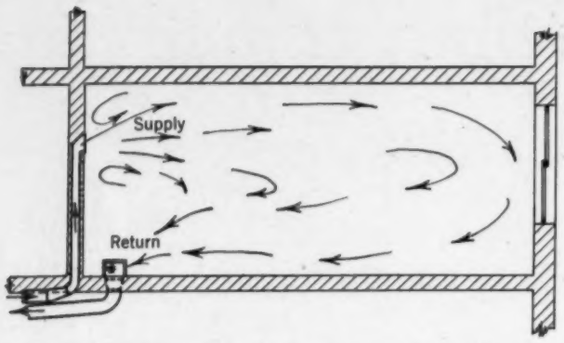


Fig. 3—Air circulation when cooling with high-supply opening and low-return opening

turn at the floor functions satisfactorily for heating, and if the second story bedrooms are also compactly arranged no individual return from each will be necessary. On the other hand, any room which is unusually exposed or which is especially remote with reference to the other rooms should have a tight, controlled return grille and duct. This return preferably may be, with a mechanical system, close to the floor below the supply grille, and with a gravity system may be close to the floor at the opposite side of the room from the supply grille.

For a combined mechanical heating and cooling system using refrigeration for cooling, no particular change in the ducts usually is necessary. It is desirable from an economic standpoint to take advantage of the natural tendency of the cooler air to remain below the warmer air over head, and anything which will bring about such stratification will effect an economy in refrigeration.

When a mechanical warm air system has adequate return ducts, appreciable cooling can be accomplished with natural means, as follows: The fan outlet usually has a by-pass duct leading to a basement window or to a chimney provided for the purpose. The return duct has an alternative shaft opening into the highest part of the house. At night, in summer, the fan may be operated to exhaust the hot air from the top of the house by the return air duct just described and the fan will blow this heated air out of doors through the window, or preferably, of course, through the chimney. The cooler night air must then enter the house through the windows, and by its motion and temperature will extract the heat from the walls and furniture. When the hot day-period approaches, the fan should be stopped and the windows closed.

Fig. 3 shows the air circulation when cooling with a high supply opening and a low return opening. The air circulation, when heating, will be substantially the same as when cooling. Fig. 4 shows a section through an elemental mechanical warm air heating-cooling system. The attic plan is alternative. Summer night cooling may, of course, be accomplished by placing an exhaust fan in the attic.

Heating by Radiators and Convectors (Class 2)

Rooms heated by radiators and which have ventilation, with air supply and exhaust openings, are encountered in office buildings and hotels, and also in residences to a limited extent. The off-hand observation of the experienced engineer will be that no satisfactory distributing arrangement for the air in such places has been devised.

The entering air may be comfortable with conventional methods of side-wall inlets, when the entering air is warmer than the air already in the room, but the radiators, lights and people always will do the heating, so that the ventilating plant practically always is a

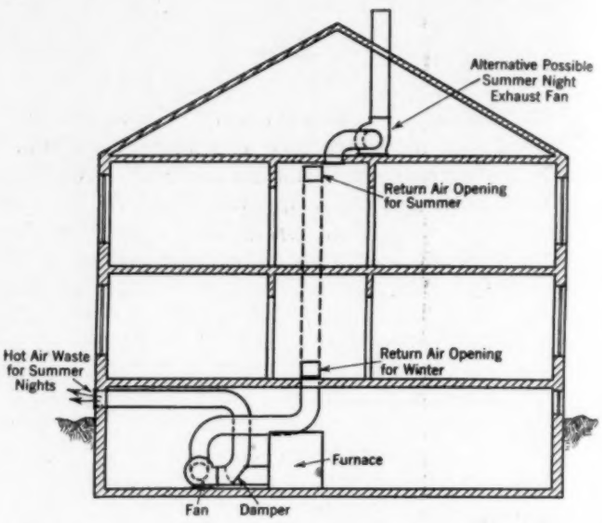


Fig. 4—Section through an elemental mechanical warm air heating-cooling system. The attic fan is alternative

cooling plant and the entering air usually must be cooler than the air already in the room; with the introduction of this cool air comes draft-complaint.

The method of air introduction of Fig. 3 will serve for cooling in a residence, since the occupants may move if they feel the draft, but it fails in an office because the occupants may be desk-tied and cannot move. The draft condition with cool air introduced in a residence as per Fig. 3, exists only in summer when perhaps a draft would be a sought-for relief. If the cool draft from such an inlet carries on also in winter, as it surely does in radiator-heated rooms, the condition is unbearable.

Rooms in this classification are usually provided with glass chutes and elaborate diffusers, and generally they are closed up with make-shift dams. When the air must be introduced, as is necessary in these rooms, at a temperature cooler for the entire year than that in the room, arrangements as per Fig. 5 have proved least objectionable. This air circuit has been found very satisfactory in spaces up to 400 sq ft in area, with ceilings as low as 8 ft. No maximum ceiling limitation has been found.

The arrangement shown in Fig. 5 is adaptable for general or private offices, and for rooms having cold exposure with radiators, or for rooms with no windows or outside walls, heated by electric lights and people. It has been found satisfactory in very large areas used for general offices and for department stores where one inlet-outlet has been provided for each construction-bay center.

When the room in question is provided with a unit

ventilator which obtains its air supply directly through the wall from out of doors, the problem of distribution is by no means easy, although with a high velocity air jet passing in an upward direction, much more tolerance may be expected than from an inlet like that shown in Fig. 3.

Experience seems to indicate that the use of unit air conditioners for summer cooling introduces no new features or difficulties which have not already been encountered in winter cooling. They must be provided with positive control by means of valves or dampers, or by both, which will prohibit any sudden and wide temperature variations, and by the time the entering air reaches the people, it must not be cooler than the air already in the space by a margin not yet definitely established, but in the order of 7 deg. It may be that this temperature-margin is dependent on the ceiling height of the room and on the velocity of the air at the discharge grille.

School Buildings

The air distribution conditions in school building classrooms (Class 3) are not unlike those illustrated in Fig. 1 for mechanical warm air systems and those in Fig. 6 for unit ventilator-equipped plants. The thermostat (Fig. 6) which controls the mixing damper and the heating unit in the unit ventilator should be in the air stream from the machine. School rooms which have center-ceiling inlets along the lines of Fig. 5 have given excellent results. It is important that the temperature of the entering air, whether this air be supplied by a local unit ventilator or by a distant central fan, be controlled so that the air cannot enter the room from a side-wall inlet or from a unit ventilator, at a temperature more than a very few degrees cooler than that of the air already near the ceiling of the room.

Fig. 7 shows a section through a room equipped with a unit air conditioner or unit cooler. This is typical of the condition in effect when any recirculating room-cooling unit is installed.

In Fig. 8 the cloakroom ceiling is furred down so as to conceal the metal air supply duct, which is close to the ceiling. The temperature of the air for ventilation is controlled usually by a duct thermostat near the fan, at a temperature not more than 5 deg cooler than the temperature required by the room thermostat.

In Fig. 9 the direct radiator is controlled by a thermostat on the wall, and the air delivered by the unit ventilator is controlled by a second thermostat in the air stream from the machine. If the corridor is used as a vent flue, in accordance with questionable practice, no particular difference in the air circulation in the room will be observed from that of Fig. 9.

Theaters

Theaters (Class 4) are generally heated or cooled with air. No heating system for a theater should be given consideration without definite provision for cooling. Theater cooling always is far more important than theater heating.

There are two widely different kinds of theater air distribution, namely, the *upward* and the *downward*. The

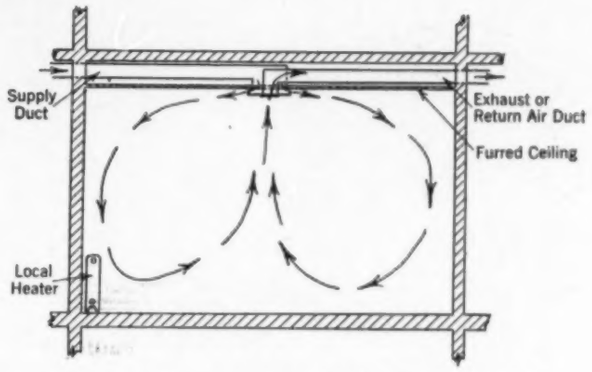


Fig. 5—Section through a radiator-heated room

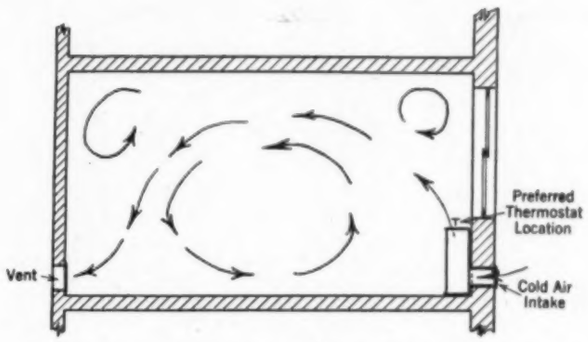


Fig. 6—Section through a unit ventilator-equipped room when heating

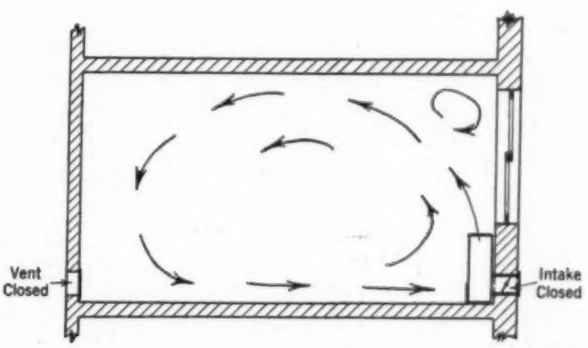


Fig. 7—Section through a unit conditioner-equipped room when cooling

upward system probably is the older. When the entire seating area is occupied, the upward system gives little trouble when cooling, and as very little heating is required under such conditions, practically no difficulty is encountered. A maximum of about 25 cfm of air per person introduced at low velocity, say 150 linear feet per minute and a temperature not more than 6 deg below the room temperature, is indicated with an upward system.

If the auditorium is only partly occupied, the cool air, which is forced in under the vacant seats has nothing to heat it, and in theaters which have sloping floors, this cold air falls down the incline and causes draft complaint from the patrons. This difficulty can be alleviated by an elaborate system of zone dampers and by painstaking manual control.

If no inlet openings are possible in the ceiling the

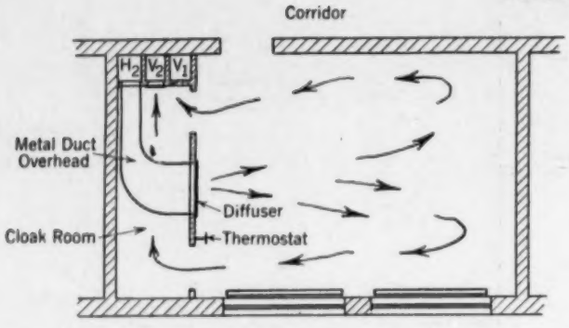


Fig. 8—Plan of a classroom in a school ventilated by a central fan

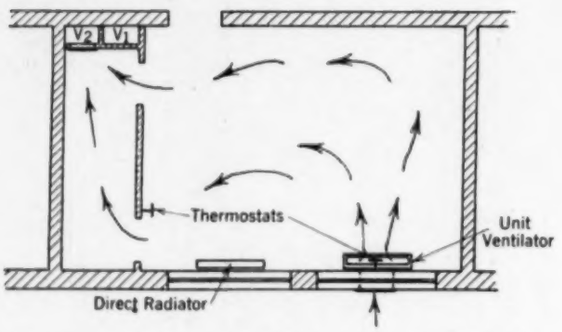


Fig. 9—Plan of a classroom in a school ventilated by a unit ventilator

upward system may be the least objectionable alternative. Fig. 10 shows a section through a theater with the upward system of air distribution. The patrons in the occupied zone often suffer from drafts due to the cool air which comes from the unoccupied zone.

Theaters under competent design usually are equipped with downward air distribution with horizontal diffusion of the entering cool air so as to combine it, both as to temperature and dilution, with the heated air which inevitably must rise from the bodies of the patrons. The waste or the recirculated air is withdrawn from the room at the floor. If the theater is large, and if the exhaust openings are placed in the side walls at the floor, drafts may be felt by the people who sit near the openings. There is no objection, however, except that of cost, to the use of small exhaust openings under each seat. These may have mushroom covers or may be cleanable floor grilles.

If the entering cool air in a downward system is not deflected horizontally, it will fall through the surrounding much hotter air, and will reach high velocities by the time it strikes the heads of the occupants. For instance, if air at 65 F and 75 per cent relative humidity for cooling is released with practically no velocity, at the top of a theater in which the air has an average existing temperature of 75 F and a relative humidity of 60 per cent, the difference in weight per cubic foot between the existing air and the new air is 0.0015 lb. If the ceiling at the air inlet location is 40 ft above the people, a column of air 35 ft high will be bearing down at the rate of 0.0525 lb per square foot more than the surrounding air. This weight is equivalent to 0.0099 in. of water and to a velocity of 380 fpm. Air forced over one's head at a temperature 10 deg below that of the surrounding air and at a velocity of nearly 400 fpm, is decidedly objectionable.

Fig. 11 shows a section through a theater with downward ventilation. There are deflectors which cause the entering cool air to be spread horizontally so that it will mix with the hotter air. The final escape is through well-distributed openings through the floor.

There have been cases in which the downward system of air distribution illustrated in Fig. 11, especially when not provided with refrigeration for cooling and not adequately controlled, gave trouble due to overheating at the rear, both above and below the balcony. It is especially necessary that adequate removal of the heated air be provided at these low-ceiling points and it is probable that auxiliary exhaust at or through the ceiling after the manner of the arrangements shown in Fig. 5 will be helpful.

Large Areas with Low Head Room

When large areas with low head room (Class 5) are to be ventilated, the inlets and outlets as shown in Fig. 5 may be used and, being overhead, have advantages due to freedom from risers which might interfere with partitions or which would increase the sizes of columns. When both the supply and the exhaust are distributed in this manner it is obvious that each construction bay is independent of every other similar bay.

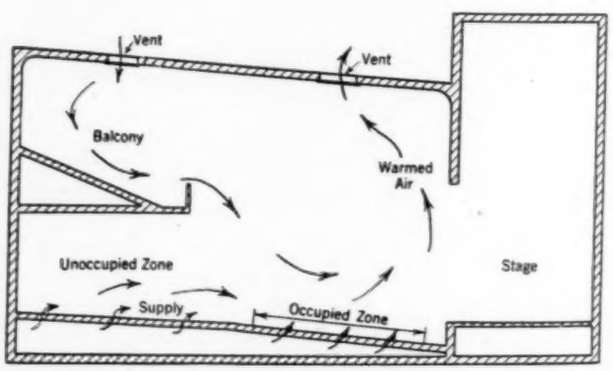


Fig. 10—Section through a theater with upward ventilation

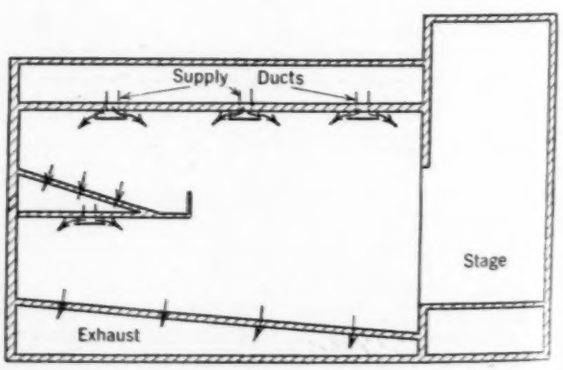


Fig. 11—Section through a theater with downward ventilation

In other cases it may be convenient to use overhead supply ducts with side-looking diffusers. These diffusers will not give a uniform and agreeable spread of the air for their dependent area unless carefully designed; it must be remembered that they receive air from the main line at comparatively high velocity, and that they are responsible for reducing this velocity quietly, and for distributing the reduced-speed air.

The conventional and objectionable branch outlet is indicated in Fig. 12. The butterfly volume damper, hinged at its center, always is objectionable. The high-speed air causes high velocity drafts and practically is uncontrollable over the dependent floor area.

Use of Vanes

Fig. 13 shows a plan of an improved duct branch. This has reference only to horizontal distribution. From the standpoint of comfort, the use of vanes behind grilles so as to cause the air to maintain an orderly and uniform travel, is important. Supply openings from vertical risers are elbows just as truly as though they had ducts at both sides, and vanes here are helpful.

Fig. 14 shows a section through a room air inlet at the top of a rising flue. Vanes can be used at this point advantageously. Fig. 15 shows a section through a room inlet opening at the top of a rising flue and indicates air conditions when no vanes are present.

Ejector Nozzles

In many cases it is advisable to take advantage of the tendency of any moving object to travel in a straight line, when designing air inlets. It is not good practice

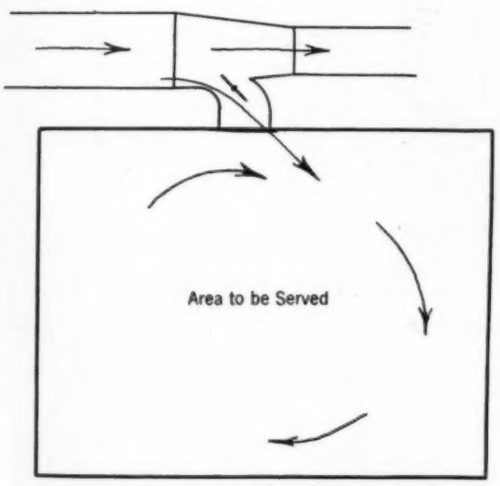


Fig. 12—Plan of conventional duct branch

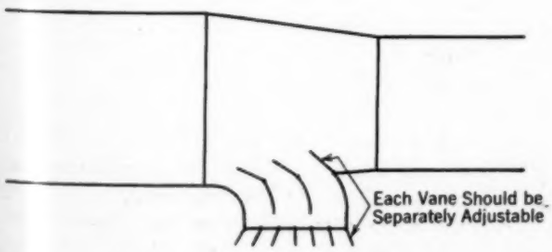


Fig. 13—Plan of improved duct branch

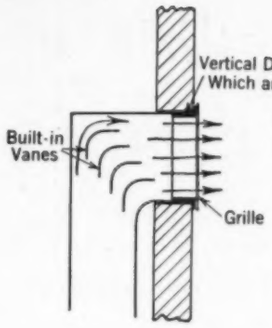


Fig. 14 (left)—Section through room air inlet at the top of a rising flue

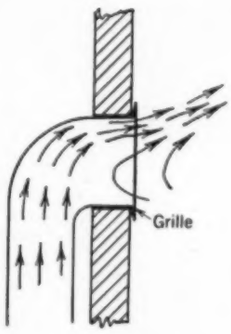


Fig. 15—Section through room inlet opening at the top of a rising flue

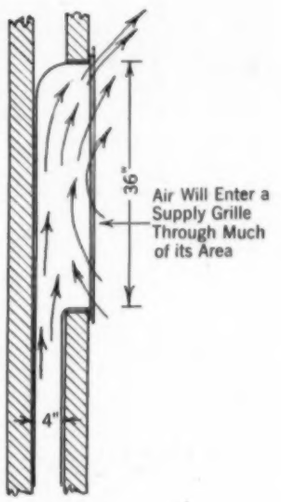


Fig. 16—Section through a shallow flue with a high grille

to design a duct say 36 in. wide and 4 in. deep for a velocity of say 1200 fpm, with a grille on that duct, say 36 in. x 36 in. The outlet velocity will not be reduced in the ratio as 4 in. to 36 in. Figs. 15 and 16 illustrate this fallacy.

In many theater and commercial installations this ejector-like effect of high-velocity air emerging from a duct is taken advantage of, and ejector nozzles scientifically proportioned are installed so as to cause definite recirculation of the room air due to the entering air.

Narrow Slot Inlets

In rooms of Class 1 in which it usually is expedient, if not always necessary, to use riser ducts 4 in. or less in depth the inlets to the rooms may be narrow slots which sometimes may be entirely invisible behind pictures and the like, as suggested in Fig. 17.

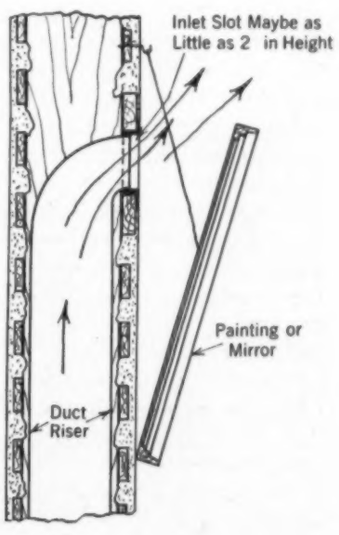


Fig. 17—Section through inlet slot for small room

Air Infiltration Through Steel Framed Windows

By D. O. Rusk[1], V. H. Cherry[2] and L. Boelter[3] (*NON-MEMBERS*), Berkeley, Cal.

THE rate of air infiltration through a window depends to a great extent upon the quality of construction of the window. For this reason, only the approximate magnitude of the leakage can be estimated from test data on similar windows. Experiments conducted at the University of Wisconsin[4] in cooperation with the A. S. H. V. E. Research Laboratory indicate a variation of leakage of from 50 to 90 cfh per foot of sash perimeter at a pressure equivalent to 25 mph wind velocity, for nine double-hung wood sash windows of similar workmanship. The width of crack perpendicular to the direction of air flow, the window size, and thickness were the same for these windows.

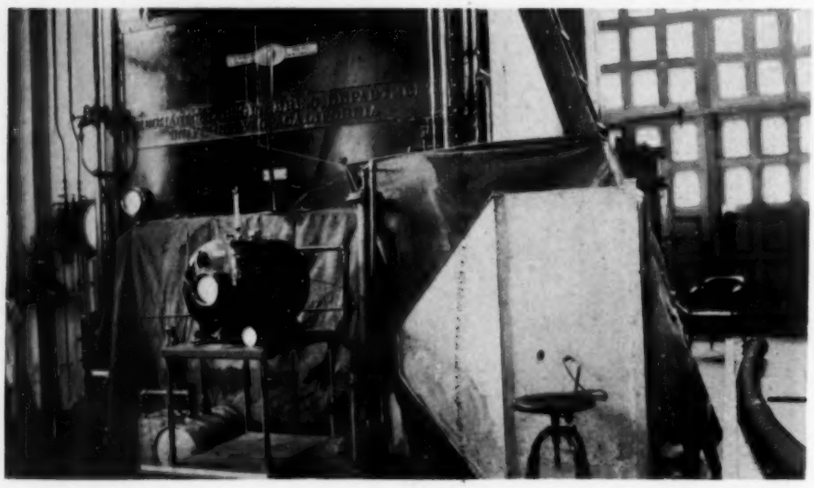
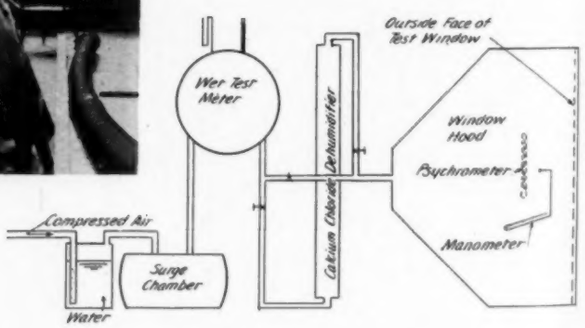


Fig. 1—Arrangement of apparatus for infiltration tests

Fig. 2—Diagram of test apparatus



The A. S. H. V. E. Research Laboratory tested steel double-hung windows actually installed in a building.[5] The results of the University of Wisconsin experiments and those of the A. S. H. V. E. Research Laboratory supplemented by further tests on swing and hung steel windows made at the University of California by the authors, are shown in Fig. 3. The leakage curves are designated by letters indicating the corresponding cross section through the leakage path. The infiltration rate for a window is specified as the volume of air leakage per minute per linear foot of crack for a given wind velocity normal to the window. The curves show the leakage as a function of the wind velocity. It may be seen that there exists a very wide variation in the performance of these windows.

Certain other variables not controllable by the manufacturer must be considered in performing tests on windows. The results given in the aforementioned papers[4-5] indicate a variation in leakage rates for latched and unlatched windows. It is an object of this paper to show that the test results obtained on steel swing windows depend upon the manner in which the window is closed and latched. Further, it has been noted that the leakage through felt weatherstripped steel swing windows depends upon the humidity of the air. Test results will be presented which indicate that for the window tested, the leakage was at least 130 per cent greater for dry air than for saturated air.

Apparatus

The apparatus used for the tests, which were conducted in the Mechanical Laboratories of the University of California, is shown in Figs. 1 and 2. The windows and casings were mounted in a steel hood with the weather side of the windows facing the air inlet, which was located at the back of the hood.

[1] Assistant in Mechanical Engineering, College of Engineering, University of California.

[2] Assistant in Mechanical Engineering, College of Engineering, University of California.

[3] Associate Professor in Mechanical Engineering, College of Engineering, University of California.

[4] See Air Infiltration Through Double-Hung Wood Windows, by Larson, Nelson and Kubasta (A. S. H. V. E. TRANSACTIONS, Vol. 37, 1931, when issued).

[5] See Air Leakage Studies on Metal Windows in a Modern Office Building, by F. C. Houghten and M. E. O'Connell (A. S. H. V. E. TRANSACTIONS, Vol. 34, 1928).

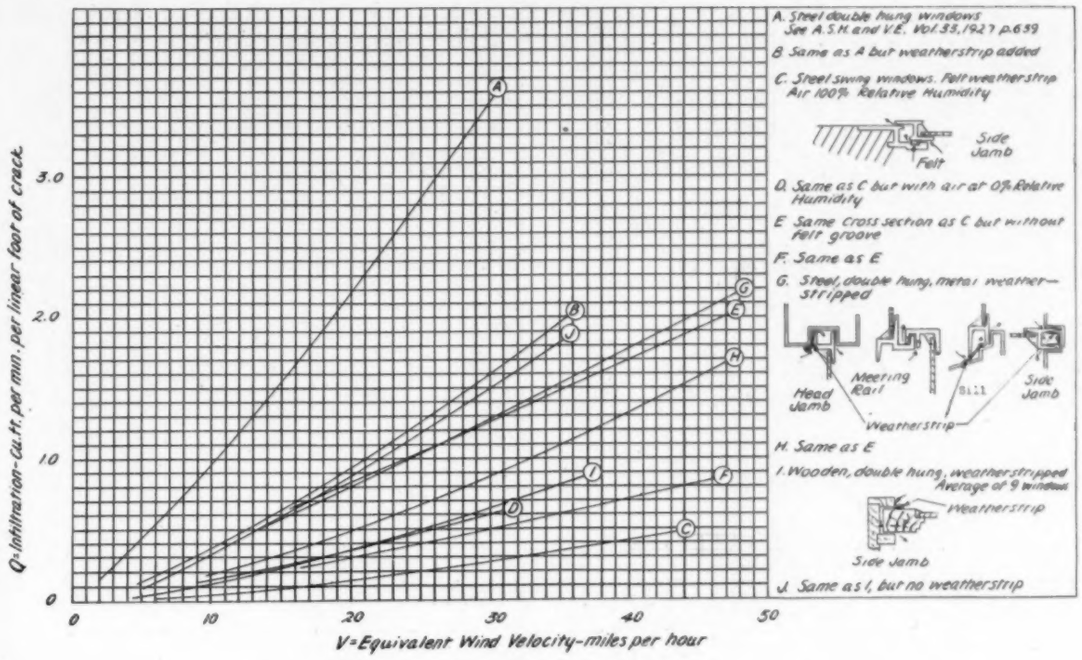

A. Steel double hung windows See A.S.H. and V.E. Vol. 33, 1927 p. 639
B Same as A but weatherstrip added
C. Steel swing windows. Felt weatherstrip Air 100% Relative Humidity
Felt
Side Jamb
D. Same as C but with air at 0% Relative Humidity
E Same cross section as C but without felt groove
F. Same as E
G. Steel, double hung, metal weather-stripped
Head Jamb
Meeting Rail
Weatherstrip
Side Jamb
H. Same as E
I. Wooden, double hung, weatherstripped Average of 9 windows
Weatherstrip
Side Jamb
J. Same as I, but no weatherstrip
Q-Infiltration-cu.ft. per min. per linear foot of crack
V-Equivalent Wind Velocity-miles per hour
0
1.0
2.0
3.0
10
20
30
40
50

Fig. 3—Infiltration through various kinds of windows

The equivalent wind velocity in miles per hour was computed from the expression

$$V = K\sqrt{\frac{2gh}{w}} = K'\sqrt{\frac{h}{w}}$$

where

K = a conversion factor = 1.55 or $K' = 12.45$

w = density of the air chosen as standard

h = the pressure head in the hood acting upon the window in inches of water. The head was obtained by means of an inclined manometer attached to the hood.

The equivalent velocity was calculated as the velocity of dry air normal to the window, at a pressure of 30 in. of mercury and at 60 F, corresponding to the actual pressure head acting across the window. Similarly the infiltration rate was calculated from the actual weight of air (and water vapor) flowing per unit time per linear foot of leakage space, as the volume of dry air at 30 in. of mercury and 60 F.

The air was supplied from a tank charged by a compressor. A wet test meter was used to measure air quantity for the lower flow rates. This necessitated saturation of the air to prevent loss of water from the meter. A Venturi tube was used for the higher flow rates.

The piping from the meter to the hood was so arranged that the air could be passed directly, or through a calcium chloride container, to the hood. The humidity of the air was considered as a variable for the felt weatherstripping tests only.

Four steel swing windows and one steel double-hung window with brass weatherstripping were tested. One of the swing windows was felt weatherstripped. The felt seal was effected by cementing a strip of felt into a groove in such a manner that the window, when closed, was pushed tightly against the felt. The steel frame and casing formed the seal for the windows tested without weatherstripping. Figs. 3 and 4 show the cross section of the leakage path and the general location of the latches.

Results Obtained

The effect of varying the method of closing and latching the door is shown in Fig. 5 for a non-weatherstripped window. Since the equivalent wind velocity is often used in specifying the infiltration rate of a window, the leak-

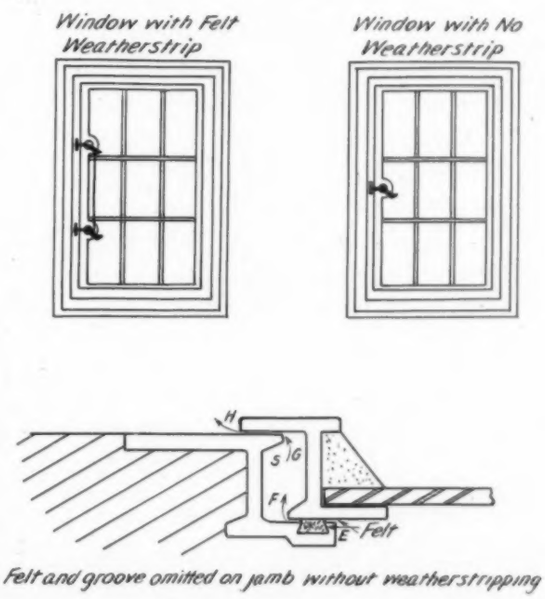


Fig. 4—Method of mounting windows in hoods and cross section of jambs on weatherstripped windows

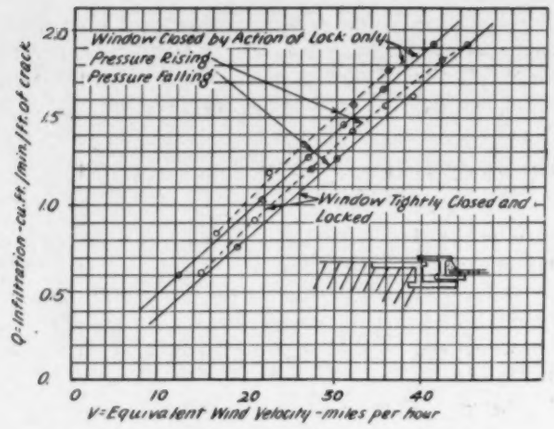

Window Closed by Action of Lock only
Pressure Rising
Pressure Falling
Window Tightly Closed and Locked
Q-Infiltration-cu.ft./min./ft. of crack
V=Equivalent Wind Velocity-miles per hour

Fig. 5—Effect of tightness of closing of window on leakage of air (window not weatherstripped)

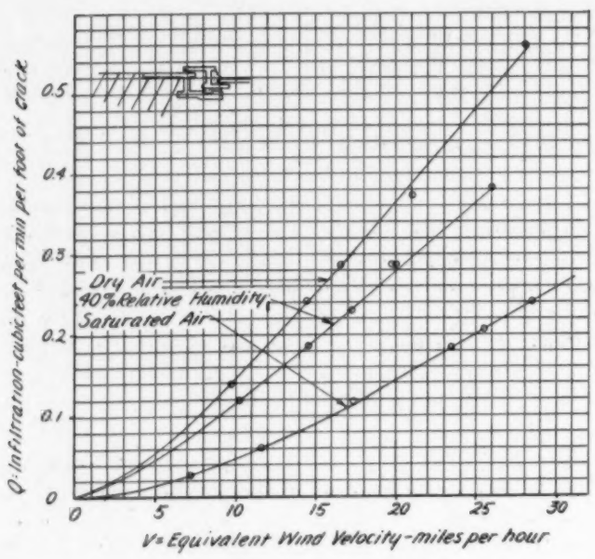

Dry Air
40% Relative Humidity
Saturated Air
Q-Infiltration-cubic feet per min per foot of crack
V=Equivalent Wind Velocity-miles per hour

Fig. 6—Effect of humidity on infiltration through felt weatherstripped metal windows

age rate (Q) is plotted against wind velocity for two conditions:

1. Window closed by action of lock only.
2. Window pulled tightly closed and locked.

It may be seen that, as the pressure on the window is increased, the window is closed tighter and remains in position as the pressure is reduced. The leakage for the first case is 10 per cent to 30 per cent greater than for the second case, which shows that the manner of closing the window has an important influence on the leakage. It was also observed that improper application of paint at the cracks materially changed the leakage rate.

Tests on the felt weatherstripped window were made at three different humidities. For 100 per cent relative humidity, the air from the meter was assumed to be saturated. Practically dry air was obtained by the use of the calcium chloride, while an intermediate humidity resulted from the use of calcium chloride not entirely dry. The humidities were measured by wet- and dry-bulb thermometers suspended in the hood. At each humidity, the flow of air for a particular pressure difference across the window was maintained until the infiltration rate became constant, which indicated that the moisture content of the felt was approximately at a maximum (corresponding to the equilibrium moisture content).

The effect of humidity on leakage through felt weatherstripping, arranged as in Fig. 4, is shown in Fig. 6. Air leakage, in cubic feet per minute per linear foot of crack, is plotted as a function of equivalent wind velocity, in miles per hour. The air leakage at an equivalent wind velocity of 25 mph as a fraction of the leakage for saturated air is shown as a function of relative humidity in Fig. 6a. It will be noticed that for this equivalent velocity, the leakage for dry air is 240 per cent of the leakage for saturated air.

If the air leakage per unit time as a function of pressure head across the window is plotted on logarithmic paper, the straight lines indicate a relation of the form: (See Fig. 7.)

$$Q = CAh^a$$

where

Q = quantity flowing in cubic feet per minute per foot of crack.
C = discharge coefficient.
A = effective area for flow through crack in square feet.
h = pressure head in inches of water.
a = exponent depending on the moisture content of the felt.

The exponent a was found to vary from 0.63 for dry air to 0.79 for saturated air. Since the leakage decreases with wet air, it is seen that the flow approaches that of the viscous type for the lower rates of flow, that is, higher humidities. In the viscous [6] region the leakage Q is proportional to the head h while in the turbulent region Q is proportional to the square root of the head, ($h^{1/2}$).

Plotting $\frac{Q}{h^a}$ against the equilibrium moisture content

[6] Gibson, Hydraulics and Its Applications, page 45.

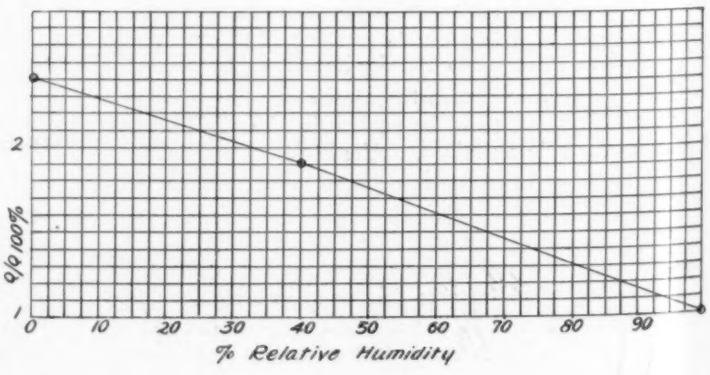


Fig. 6-a—Ratio of infiltration of partially saturated air to infiltration of saturated air through a felt weatherstripped window. (Equivalent wind velocity, 25 mph)

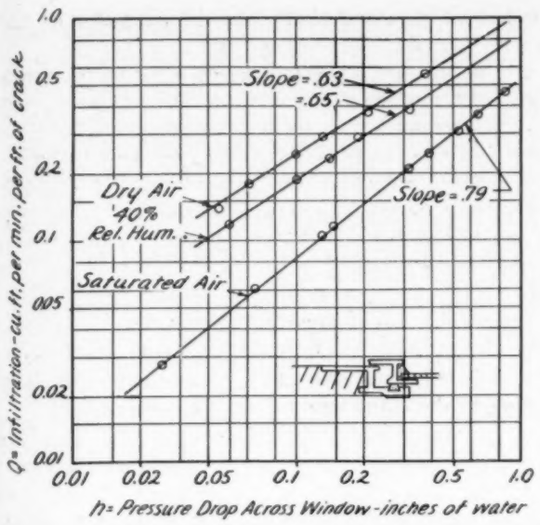


Fig. 7—Effects of humidity on infiltration through felt weatherstripped metal windows

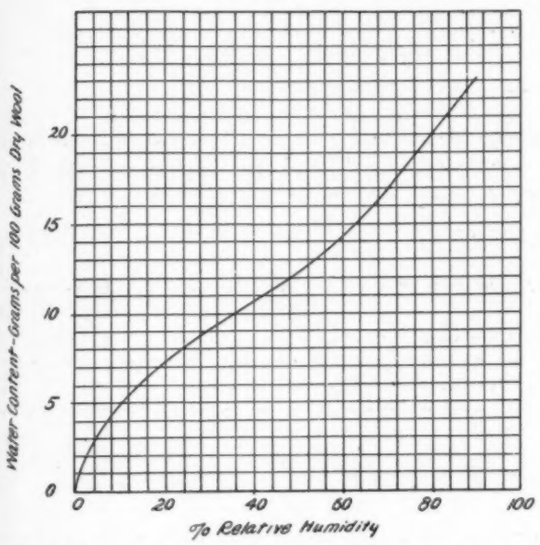


Fig. 8—Equilibrium moisture content of worsted wool at 25 C*

*International Critical Tables, Vol. 2, pp. 222-225

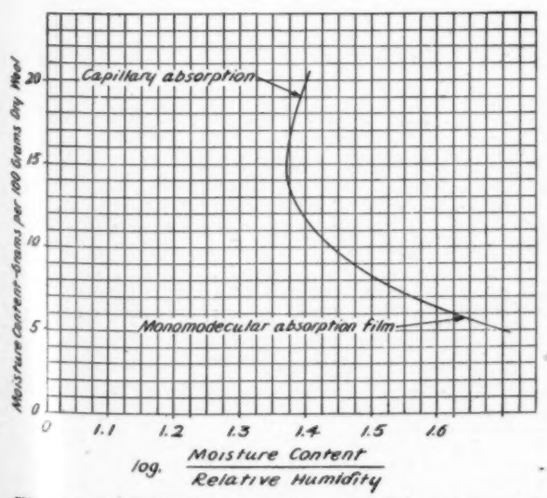


Fig. 8-a—Equilibrium moisture content of worsted wool at 25 C

of felt (obtained from Fig. 8) yields an approximately straight line as shown in Fig. 9. The moisture content[7] of wool felt plotted in Fig. 8 was taken from the International Critical Tables, Vol. 2, page 222-25.

The results plotted in Fig. 9 indicate that $CA\ (=\frac{Q}{h^a})$, the product of the discharge coefficient (C) and the cross sectional area (A) of the leakage path, and consequently the area (A), is influenced by the moisture content of the felt. This curve is plotted with but three points and therefore should only be interpreted as indicating a general trend.[8]

The leakage path is shown by the arrows in Fig. 4. The resistance to flow may be regarded as consisting of an entrance loss at E, friction loss through the path bounded by metal, friction loss through the felt, friction through the remainder of the first crack, expansion loss at F into space S, the friction loss due to flow through space S (which is small), entrance loss at G, friction loss through GH and exit loss at H. The change in the product of the coefficient of discharge (C) and the effective cross sectional area (A) of the leakage path for a given flow rate is partly due to the variable moisture content of the felt corresponding to various air humidities.

The actual variation in CA as the relative humidity is changed from 0 per cent to 100 per cent may be partially obscured by the decrease of frictional losses other than that through the felt. This would be due to the smaller infiltration rate and the consequent decrease in velocity through the leakage path. The loss in head due to sudden expansion[9] may be shown to vary with the square of the difference of the velocities before and after the expansion.

By means of the law of continuity it may be shown that the head loss is proportional to the square of the velocity through the smaller cross section. Similarly the head loss due to sudden contraction may be shown to be proportional to the square of the velocity in the smaller cross section. These two head losses (the latter being the smaller of the two) partly explain the deviation of the flow from the viscous flow law.

Replotting the equilibrium moisture content curve, Fig. 8, of wool felt in accordance with the method outlined by Bray and Draper,[10] assuming the relative humidity to be directly proportional to the partial pressure of the water vapor yields Fig. 8a. This curve indicates that for relative humidities less than 50 per cent the phenomenon is one of adsorption, while above 50 per cent relative humidity, capillary condensation (absorption) occurs.

From Fig. 9 $\frac{Q}{h^a}$, that is the product CA, varies from 1.02 to 0.52. If C is assumed constant, then the variation of cross sectional area of flow, due to the change of

[7] See also Hougen and Watson, Industrial Chemical Calculations, page 168.

[8] Further tests are now being conducted in which the diameter of a felt thread, the equilibrium moisture content, and the pressure drop through felt at various compression pressures are being determined for different humidities.

[9] Gibson, Hydraulics and Its Applications, pages 91 and 99.

[10] Capillary Condensation and Absorption, Bray and Draper, Proceedings *National Academy of Sciences*, Vol. 12, No. 5, 1926.

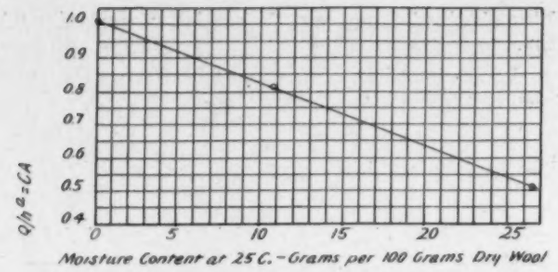


Fig. 9—Effect of equilibrium moisture content on flow of air through wool felt

moisture content of the felt, is 49 per cent. This would represent the magnitude of the change of leakage rate, if the flow did not become more viscous as the area decreased. However, from Fig. 6, at an equivalent velocity of 25 mph, the air leakage rate falls from 0.48 to 0.20 cfm per foot of crack with the change from dry to saturated air. This decrease of 58 per cent is due both to the loss of area and change of the character of flow.

Conclusions

1. A wide variation in the infiltration rate of well constructed windows may be expected. Fig. 3 shows variation of 1400 per cent at an equivalent velocity of 25 mph (compared to the smallest leakage shown).

2. Test results on windows differ widely depending upon the method of closing and latching. Variations of 15 per cent at 25 mph are indicated in Fig. 5.

3. The air leakage for steel swing windows is found to differ when determined with ascending and descending pressure differences because the window is closed more tightly after completion of the ascending pressure difference tests.

4. Test results on felt weatherstripped windows vary widely with air humidities. A 140 per cent increase is shown for dry as compared with saturated air at an equivalent air velocity of 25 mph.

5. It would seem desirable that the specifications for window tests include reference to the preceding Items 2, 3, and 4.

RESEARCH — OPTIMISM — CONFIDENCE

G. L. Larson, *Chairman,* Committee on Research

A. LINCOLN FILENE once wrote, "Some people consider research a dull and sleepy affair. To me, research is full of dynamite. In the hands of a competitor, it can strew your own business path with heart breaking obstacles. Used by yourself, it can blast your way to success. If you are *NOT* using the research method to find new and better ways of manufacturing your products, now or in the future, your competitor is doing so, make no mistake about that."

Mr. Filene refers to the manufacturer but his statement holds equally true for the Engineer. A successful engineering practice is built on fundamental knowledge and fundamental knowledge comes only through profound research in one form or another.

In spite of the times, optimism prevails regarding research sponsored by our Society. Manufacturers' contributions to our research fund have been more than generous considering present financial handicaps that affect them all. Those who have been unable to contribute have been generous in their praise of the Research Laboratory's accomplishments and sincere in their regret that they are unable to contribute to the work. That a spirit of optimism regarding the Research Laboratory prevails among our membership is shown by the various discussions at the June meeting in Milwaukee.

The Research Laboratory of the American Society of Heating and Ventilating Engineers is supported by a share of the dues of the members, plus a share of the profits of The Guide, plus gifts from its friends. Naturally, in times like these, all of these sources of income have been reduced and some curtailment of activity is necessary to balance the budget.

The Committee on Research is making every possible effort to cut the suit to fit the cloth. Some co-operative research agreements with universities are being temporarily discontinued and others are being reduced. No new agreements are being entered into except those sponsored by special funds. A considerable reduction in expense has been brought about at the Research Laboratory at Pittsburgh and the new agreement with the United States Bureau of Mines will be helpful in this direction.

On the other hand, projects sponsored by special funds are increasing. Among these may be mentioned:

1. Work at Harvard on the effect of ionization on the health and comfort of man, sponsored by a $1,000.00 contribution from our Past President W. H. Carrier.
2. Summer cooling for homes being studied at the Research Residence of the National Warm Air Heating Association at the University of Illinois, sponsored by contributions of $1,000.00 and $1,500.00 from two large organizations, and a tentative promise of another $1,000.00 toward this work has been received from another interested association.
3. Investigation of minimum air requirements for ventilation to be carried on probably at some university where we already have a co-operative agreement.

This latest inspiring example of cooperation and of devotion to the ideals and purposes of the Society makes it possible for the Research Laboratory to carry out its long cherished ambition of conducting research to determine authoritatively the minimum amount of outside air per person which must be introduced into an enclosure in relation to the air movement within the enclosure.

A minimum budget of $1800.00 was estimated for the purpose and sponsored by the *National Association of Fan Manufacturers* and lead by our fellow member Mr. J. F. G. Miller, a voluntary member of the Research Finance Committee through Mr. Carrier's happy interposition, the $1800.00 has been underwritten by the following:

National Association of Fan Manufacturers
American Air Filter Co.
American Blower Corp.
Buffalo Forge Co.
Carrier Engineering Corp.
Clarage Fan Co.
Garden City Fan Co.

Heating and Piping Contractors National Association
Holtzer-Cabot Electric Co.
Ilg Electric Ventilating Co.
Herman Nelson Corp.
John J. Nesbitt, Inc.

Johnson Service Co.
National Regulator Co.
New York Blower Corp.
Peerless Unit Ventilation, Inc.
Powers Regulator Co.
B. F. Sturtevant Co.

Such specific research contributors as these inspire us with a feeling of optimism. Through the haze and mists of the twilight, we catch a glimpse of a rosy and hopeful dawn and view the future with confidence.

River front at Cincinnati

39th Annual Meeting of A. S. H. V. E.

THREE days, January 23 to 25, 1933, should be reserved by members for attending the 39th Annual Meeting of the Society which will be held under the auspices of the recently organized Cincinnati Chapter. The Committee on Arrangements under the general direction of W. C. Green has been organized and hotel headquarters have been selected. The Hotel Gibson will be the meeting place. Its location is in the center of Cincinnati's retail, financial and amusement district, convenient to railroad stations, bus and electrical terminals. Room rates are moderate ranging from $2.50 to $7.00 single and $4.00 to $9.00 double.

Hotel Gibson, meeting headquarters

Cincinnati is a convenient place to visit because of its location, within a few miles of the center of population. A great new railway terminal is now under construction calling for an expenditure of $41,000,000, and its opening is scheduled for the early part of 1933. Reduced railroad rates will be in effect for this meeting and a large attendance is hoped for by the Cincinnati members.

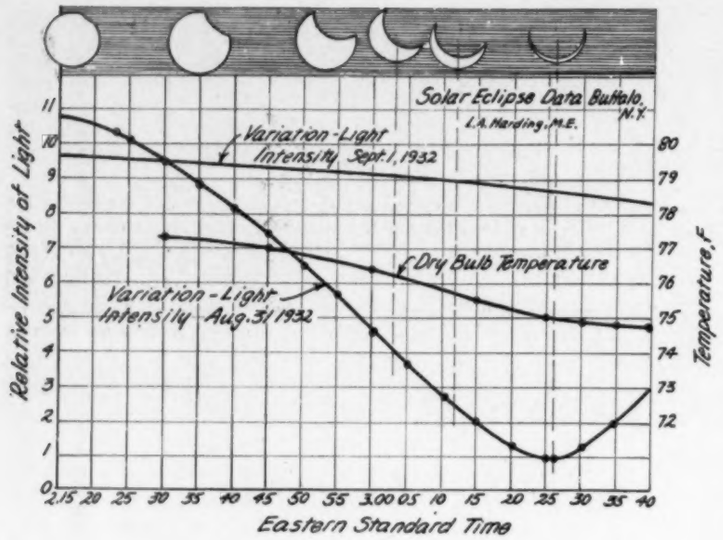
Cincinnati is situated on the hills that line the winding Ohio River and is rich in natural beauty and Longfellow called it, "Queen City of the West." The city was founded December 29, 1788, and was first known as Losantiville, the name later being changed to Cincinnati by General St. Clair. It was incorporated as a village in 1802 and became a city in 1819. It is widely famed as a music and art center and its Symphony Orchestra is an outstanding organization. It has many historic and interesting buildings, comfortable homes and places of recreation.

The University of Cincinnati with a campus of 50 acres is the only municipal owned and supported University in the country and an unique feature is its system of cooperative education. The Public Library of Cincinnati contains over a half million volumes and the Art Museum possesses a rare collection of sculpture, paintings, etchings, carvings and costumes. The world famous Rookwood Pottery, distinguished for its artistic specimens of ceramic ware, is located on Mt. Adams. Cincinnati Zoological Gardens are one of the oldest in America and an exceptional collection of bird and animal life. Burnet Woods is one of the beauty spots adjoining the University of Cincinnati and contains 160 acres of tree covered hills. The city has 90 public parks with a total of 2661 acres and an extensive boulevard system.

Cincinnati enjoys a reputation for its hospitality, culture and civic achievement and the Cincinnati members want their fellow members to come for the 39th Annual Meeting in January.

The personnel of the Committee on Arrangements selected by the Chapter's Officers and Board of Governors is as follows:

W. C. Green, *General Chairman*
H. N. Kitchell, *Vice-Chairman*
J. J. LaSalvia, *Chairman, Reception Committee*
E. B. Royer, *Chairman, Registration Committee*
H. M. Rudio, *Chairman, Entertainment Committee*
H. E. Sproull, *Chairman, Banquet Committee*
R. B. Breneman, *Chairman, Ladies' Committee*
I. B. Helburn, *Chairman, Transportation Committee*
J. J. Braun, *Chairman Publicity Committee*
C. J. Kiefer, *Chairman, Finance Committee*



L. A. Harding Charts Eclipse

In the *Buffalo Evening News* of September 6, 1932, L. A. Harding, Buffalo consulting engineer and past-president of the Society, was pictured with the apparatus he had developed for measuring the intensity of light during the Solar Eclipse, August 31.

A photronic cell was used for measuring the light intensity in conjunction with a milli-ammeter. A record of Mr. Harding's observations during the eclipse, and also on the following day, are shown on the accompanying chart.

Heating Specialists Organize

The organization of Emerson Swan Goodyer Co., 110 Arlington St., Boston, Mass., has been announced and the company will specialize in steam heating lines, marketing through the wholesalers of the New England States. The company will handle Hoffman heating systems, traps, valves, pumps and specialties as well as the products of the Massachusetts Steam Specialty Co. and the General Fittings Co.

Cucci & Brown to Practice Engineering

Announcement is made by Victor J. Cucci and William A. Brown, consulting engineers, of the opening of offices for the practice of engineering under the name, Cucci & Brown, Inc., at 347 Madison Ave., New York.

Mr. Cucci was formerly a member of the firm of Kimball & Cucci, consulting engineers, and he has specialized in heating and ventilating, plumbing and sprinkler work. He is a licensed professional engineer in the State of New York, a member of the *New York State Professional Engineers Society*, the *American Society of Mechanical Engineers* and the A. S. H. V. E.

Mr. Brown has been in the consulting field specializing in electrical and mechanical equipment of buildings since his graduation from Harvard Engineering School in 1923. Formerly he was with J. J. Livingston & Co., Griggs Fuller and Clark, and French & Hubbard before establishing his own business in 1930. Mr. Brown is a licensed professional engineer in the State of New York, is a member of the *New York State Professional Engineers Society*, a member of the *American Institute of Electrical Engineers, Harvard Engineering Society* and the A. S. H. V. E.

Death of E. L. Jaynes

The death of E. L. Jaynes, president of the Michigan Warming & Ventilating Co., Grand Rapids, Mich., occurred on August 23, 1932, in his 63rd year. He was born on July 31, 1869, at Toledo, Iowa, and spent his entire business career from 1890 in the warm air heating field. In 1902 he became identified with the XXth Century Heating and Ventilating Co. and from 1904-1909 was in charge of their western business with headquarters at Chicago. In 1910 he established the Northwestern Furnace and Supply Co. at Minneapolis and for many years was its president and general manager. In 1925 he became identified with American Foundry and Furnace Co. and in 1928 joined the Michigan Warming and Ventilating Co.

Mr. Jaynes joined the Society in 1918 and became one of the charter members of the Western Michigan Chapter when it was organized in Grand Rapids.

The Officers and Council regret the passing of their fellow member and extend their sincere sympathy to the members of his family who survive.

Death of George D. Hoffman

The heating industry lost one of its pioneers when George D. Hoffman died at his home, in Pasadena, Calif., on September 5. His many friends in the profession and industry will learn with regret of his passing at the age of 74, for it marks the end of a career rich in friendships and notably successful in his chosen field.

Mr. Hoffman was a Charter Member of the Society and was always an ardent supporter of its activities, particularly of its research program. At the time of his death he was president of the Hoffman Specialty Co., Inc., and, although always keenly interested and in touch with the affairs of his company, he had for some years lived in California where he devoted much of his time to the development of electrical heating appliances for use on the West Coast. The present executives of the company will continue the Hoffman Specialty Co., Inc., on the same policies originally laid down by its founder.

George D. Hoffman

Mr. Hoffman was born in Chicago, Ill., March 13, 1858, and began a life association in the heating industry after completing his schooling. His experience covered a wide field in engineering, contracting and manufacturing. In 1913, after perfecting the Hoffman air valve, he organized his own company for their manufacture and the production of other heating specialties.

Mr. Hoffman is survived by his wife, three sons and two daughters, to whom the Officers and Council of the Society extend their sincere sympathy for the great loss that they have sustained.

NOMINATIONS FOR 1933

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1933, submits the following list of nominees:

For President:

W. T. JONES, Boston, Mass.

For First Vice-President:

C. V. HAYNES, Philadelphia, Pa.

For Second Vice-President:

JOHN HOWATT, Chicago, Ill.

For Treasurer:

D. S. BOYDEN, Boston, Mass.

For Members of the Council:

Three-Year Term

R. H. CARPENTER, New York, N. Y.
J. D. CASSELL, Philadelphia, Pa.
F. C. MCINTOSH, Pittsburgh, Pa.
L. WALTER MOON, St. Louis, Mo.

Respectfully submitted,

NOMINATING COMMITTEE

H. M. HART, *Chairman*

Chapters	*Representative*
Cleveland	C. F. EVELETH
Illinois	H. M. HART
Kansas City	B. NATKIN
Massachusetts	C. P. YAGLOU
Michigan	W. G. BOALES
Western Michigan	S. H. DOWNS
Minnesota	C. E. LEWIS
New York	H. M. WYLIE
Western New York	JOSEPH DAVIS
Ontario	W. G. SHEPPARD
Pacific Northwest	
Philadelphia	W. ROY EICHBERG
Pittsburgh	F. C. MCINTOSH
St. Louis	C. A. PICKETT
Southern California	L. H. POLDERMAN
Wisconsin	J. G. SHODRON

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. 9—*Section* 2. The Nominating Committee shall consist of a member designated by each Chapter, which shall effect its own organization and elect its own Chairman.

Section 3. The Committee may meet at the call of the Chairman, for discussion, but the official meeting shall be held at the Semi-Annual Meeting of the Society, at which time the candidates for each of the offices of the Society to be filled at the next Annual Meeting shall be selected by a majority vote of the members of the Committee present and voting. Five shall constitute a quorum.

Section 4. The Committee shall first secure the consent of all candidates selected, and shall, if possible, announce the names of the candidates at the Semi-Annual Meeting, but in any case the names of the candidates shall be certified to the Secretary of the Society at least four months before the next Annual Meeting. The Secretary shall publish these names in the October issue of THE JOURNAL.

Art. 10.—*Section* 3. The Secretary shall prepare ballots with the names of all candidates and forward them to the members at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception, that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and revised January, 1930, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1933:

3 Year Term

ALBERT BUENGER, St. Paul, Minn.
S. H. DOWNS, Kalamazoo, Mich.
H. N. KITCHELL, Cincinnati, Ohio
HOMER R. LINN, Chicago, Ill.
PERRY WEST, Newark, N. J.

1 Year Term

E. N. SANBERN, Philadelphia, Pa.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

SECTION I—ORGANIZATION

Research Committee

1. There shall be a standing committee known as the Research Committee, consisting of fifteen members, each serving for three years, and five retiring each year.

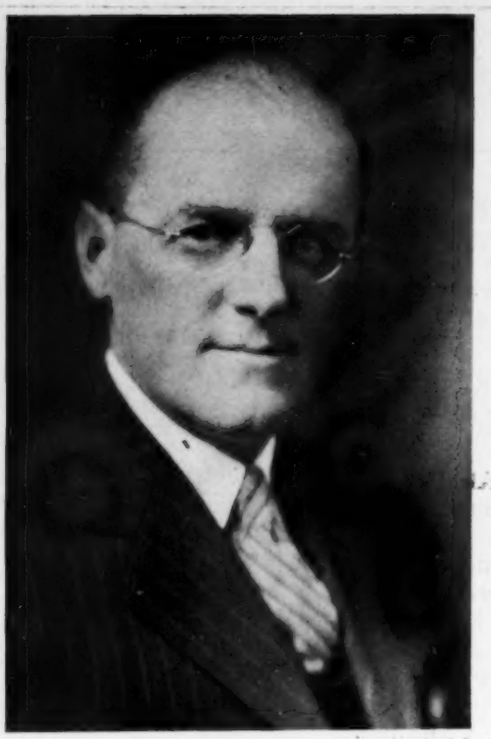
a. The Council shall nominate previous to October first of each year five members to fill the vacancies of those retiring at the next Annual Meeting.

b. The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

c. Prior to December first of any year, any ten members, over their own signatures, may nominate one or more additional members of the Research Committee, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

d. The election shall otherwise conform to the regulations provided for the election of officers of the Society.

e. Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.



W. T. JONES
Boston, Mass.
For President

C. V. HAYNES
Philadelphia, Pa.
For 1st Vice-President

JOHN HOWATT
Chicago, Ill.
For 2nd Vice-President

D. S. BOYDEN
Boston, Mass.
For Treasurer

Officers Nominated for 1933

R. H. Carpenter
New York, N. Y.

J. D. Cassell
Philadelphia, Pa.

F. C. McIntosh
Pittsburgh, Pa.

L. W. Moon
St. Louis, Mo.

Nominees for Council 1933

Local Chapter Reports

Southern California

The Southern California Chapter of the A. S. H. V. E. began its activities in 1931 under the following officers:

President—F. R. Winch
Vice-President—L. H. Polderman
Secretary—E. H. Kendall
Treasurer—Leo Hungerford
Board of Governors—M. M. Lawler, W. H. C. Ness, O. W. Ott.

The first meeting was a dinner meeting on November 10 at the Natural Gas Bureau and monthly meetings since that date have been held according to the report given by Secretary E. H. Kendall.

Some of the most interesting papers read were as follows: Discussion of Electric Motors, the Principles of Manufacture, with particular reference to Quiet Operating Motors for Ventilating Jobs; which meeting also included a trip through the U. S. Electrical Co.'s plant. A two-meeting discussion was held on the various types of refrigeration, which included Multiple Effect, Centrifugal, Reciprocating and Rotary. There was a meeting held under the auspices of the California Institute of Technology, which gave a demonstration to the engineers and their friends of the high velocity aeronautic wind tunnel, and also of the million-volt transmission and testing laboratory. The chapter also had a meeting under the auspices of the Chemical Warfare Division of the United States Army, which included a talk and motion pictures on Chemical Warfare, and the Effect of Gas upon the Atmosphere.

Last, but not least, the Chapter—with the able guidance of Program Chairman Polderman, attended a stag party at one of the clubs that will long be remembered.

Secretary Kendall reports an average attendance over a period of nine months of 94 members and guests. The smallest attendance due to inclement weather was 40 and the highest was 231 at the California Tech Meeting.

At the first meeting of the 1932 season, October 18, new officers are to be elected and the featured speaker will be Prof. F. B. Rowley, President of the Society.

Illinois

A summary of the Illinois Chapter meetings held during the past year is given by Secy. C. W. DeLand as follows:

Meeting	Attendance	Speaker	Subject
October	57	G. L. Larson	Some Research on Air Filtration and Air Movement
November	125	H. B. Johns	Natural Gas and the Pipe Line to Chicago
December	53	John Howatt A. H. Goels S. R. Lewis H. M. Hart J. A. Sutherland J. F. Hale Dr. E. V. Hill	Round Table—Code Making
January	90	L. D. Gayton	Chicago as a Seaport
(Ladies Night)	27		
February	145	E. A. Jones	Air Conditioning in its Application to the Home
March	110	F. B. Rowley	Conductivity of Wall Materials, Motion Pictures: Flight of Birds, Research by Motion Pictures
April	81	H. J. Schweim M. A. Smith	Developments in House Insulation Architectural Acoustics
May	57	S. I. Rottmayer	Forced Circulation Hot Water

The Golf Tournament was held in conjunction with the *Western Trade Golf Association.* Six Illinois Chapter Members attended who were not members of this organization.

At the Annual Meeting of the Society held at Cleveland, Ohio, 47 attended from Illinois Chapter while at the Summer Meeting at Milwaukee, Wis., 38 Chapter Members attended.

The Officers and Committees are:

President—J. J. Aeberly
Vice-President—J. H. O'Brien
Secretary—C. W. DeLand
Treasurer—C. W. Johnson
Board of Governors—H. P. Reid, A. G. Sutcliffe, Eugene Mathis.

Legislative
J. H. O'Brien
H. M. Hart
E. V. Hill
E. P. Heckel

Finance
C. W. Johnson
J. C. Matchett
R. B. Hayward
J. F. Hale
John Howatt

Better Relations Commission
H. G. Thomas
R. B. Hayward
Homer Linn

Meetings and Publications
C. W. DeLand
John Howatt
Carroll Baumgardner
S. I. Rottmayer
J. J. Haines
P. J. Marschall
J. D. Small
W. J. Mauer

Membership
Eugene Mathis
Geo. Blanding
J. J. Hayes
C. W. DeLand
Homer Linn
P. J. Marschall
L. L. Narowetz
L. J. Pitcher
G. W. Schuengel

Kansas City

A very successful year has been enjoyed by the Kansas City Chapter and a resumé of 1931-1932 meetings has been prepared by Secretary D. D. Zink.

The June, 1932, meeting of the Kansas City Chapter was largely a social affair, being held at Quiviri Lake Club House, where some 35 members and guests and their families gathered, first for golf, swimming and motor boat riding and later for a wonderful chicken dinner during which they were entertained by an outstanding string trio. After the dinner the colored quartet which sings over WDAF, the broadcasting station of the *Kansas City Star,* "The Humming Birds", entertained the Chapter and their guests for some time.

The following officers were elected at this meeting:

President—W. A. Russell
Vice-President—David Caleb
Secretary—D. D. Zink
Treasurer—Emil Haas
Board of Governors—J. M. Arthur, H. D. Betz, Carl Weiss.

The two high lights of the year's activities were first, the visit of President F. B. Rowley and Secretary A. V. Hutchinson, at which meeting President Rowley presented his paper, Looking Ahead in the Heating and Ventilating Industry, and Secretary Hutchinson gave a resumé of the Society activities and a picture of the economic set-up of the Society, dramatizing the value of its work to its membership.

The other outstanding meeting was the occasion of Prof. A. C. Willard presenting to the joint meeting of the Kansas City and St. Louis Chapters, a most interesting discussion of the research work being done in cooperation with the Society at the University of Illinois in the matter of heating, ventilating and air conditioning, outlining also his work on the Chicago tunnel.

Other technical features of the year's work included a review of the work being done at Kansas University in garage ventilation research by Prof. A. H. Sluss, in which the Kansas City Chapter has aided to the extent of $75.00 during the past year; a most enlightening talk by Mr. Evans of the General Electric Company on the application of electricity to the heating and ventilating industry; an able discussion of the proposed heating and ventilating code headed by E. K. Campbell; a presentation of Dean Langsdorf's paper on Smoke Control, which was given at a joint meeting of engineering bodies in Kansas City; a paper and discussion on the fundamentals of school house ventilating by E. H. Beling and L. F. Nordine of Moline, Ill.; a discussion of boiler feeders and accessories and boiler operation by E. N. McDonnell of Chicago, Ill.; a film showing high speed air by motion pictures, made by Baron Shiba; and a presentation of the problems involved in space cooling with ice, presented by Arthur Hardgrave of the City Ice Company.

Civic features of the Chapter's meetings during the year included a most interesting and forceful presentation of the problems of National Defense and National Integrity by Col. Fred Whitten; a call to arms and complete discussion and educational campaign regarding the school tax bill which was passed; a complete study of a proposed employment agency for unemployed engineers; call to arms on both the Boy Scouts' Drive and the annual Kansas City Charity Drive, both of which the Chapter takes a good deal of pride in supporting to their utmost; the Chapter's plans in connection with the Washington Day celebration; Prof. Sluss' study in connection with the Government Coal Commission of Kansas; a study made and resolution passed regarding the State Engineer's Licensing Bill and many other minor features.

Michigan

During the past year 13 meetings were held from October, 1931, to May, 1932, the policy of holding alternate meetings at manufacturing plants was inaugurated and proved to be very successful. The present officers plan to continue this feature to some extent during the coming year and have announced the following program for the remainder of 1932:

October—Merchandising of Mechanical Equipment
November—Controls
December—Air Conditioning

The Officers of the Chapter serving for 1932-33 are as follows:

President—L. L. McConachie
Vice-President—H. E. Paetz
Treasurer—E. H. Clark
Secretary—G. D. Winans
Board of Governors—R. K. Milward, J. W. Snyder, A. C. Wallich.

A review of the past chapter season prepared by Secy. G. D. Winans gives some observations on the various meetings.

October 12, 1931—Sixty-five members and guests were present at the first meeting of the season held at the Cadillac Athletic Club. Prior to the regular meeting, the officers and committeemen decided on semi-monthly meetings for educational purposes, these to include any desired subject as requested by the members. It was the consensus of those present that this was a long-felt need and will be met with enthusiasm by the members.

After roll call, Pres. G. H. Giguere introduced A. V. Hutchinson, the national secretary of the Society, who told of the work being done in other Chapters and of the work carried on by the Research Laboratory in connection with 10 colleges. J. R. McColl, Past President of the National Society, next told of the forming of a Chapter at Grand Rapids.

Willis H. Carrier, national president of the Society, then gave an address on the Standards and Requirements of Ventilation. Mr. Carrier had some new and interesting curves showing the optimum temperature for comfort in both summer and winter, and pointed out the different requirements for the two seasons. He stated that 25 to 30 cu ft per occupant per minute was the desired amount of air to introduce into a ventilated space and that from 7 to 10 cu ft of this should be fresh air to remove body odors. Mr. Carrier stated that under no consideration should air be introduced into a room with a velocity of more than 50 fpm, and that from 15 to 25 cu ft per minute, as measured by the Kata thermometer, are desirable. This may be increased, however, if the temperatures are higher than 80 F.

October 26, 1931—After an inspection of the dust laboratory and the manufacturing plant of the American Blower Co., the meeting was called to order in the Research Laboratory by Mr. Rollins. Mr. Anderson was introduced and gave an explanation of fan development and testing.

He ran an actual fan test and he stated that it was very difficult to test fans in the field due to the lack of straight runs of ducts, the difficulty of measuring the velocity pressure and the lack of standard connections.

There were about 100 persons present, including 50 students from the Wilbur Wright High School.

November 16, 1931—The November 16 meeting was held at the Cadillac Athletic Club, with 42 members and guests in attendance. President Giguere called upon N. B. Hubbard who reported upon the activities of the Building Congress in Detroit and invited the Chapter to attend a dinner to be given by this organization.

W. G. Boales reported on the founding of the Western Michigan Chapter at Grand Rapids where 30 men attended the first meeting.

President Giguere then invited Chapter members who were looking for business connections to present their names so that he could assist in furnishing leads to them through the cooperation of the national organization.

Prof. Linsenmeyer of the University of Detroit invited the Chapter to attend a meeting to be held at the University of Detroit on December 2, to see tests of vacuum pumps.

C. E. Lewis, of Minneapolis, was a guest at this meeting and in response to a request by President Giguere, he told of plans which are being made and of work which has been accomplished during the last 18 months in perfecting air conditioning systems for homes. This is generally recognized to be a comparatively new field which holds unlimited possibilities.

The speaker of the evening was Harvey Campbell, Vice-President and Secretary of the Detroit Board of Commerce.

December 2, 1931—The technical meeting was held in the University of Detroit Engineering Laboratory and A. C. Wallich introduced Professor Linsenmeyer who explained the methods of testing vacuum pumps.

December 14, 1931—About 50 members and guests were present at the dinner-meeting. President Giguere nominated G. D. Winans as Chapter representative on the Nominating Committee with Wm. G. Boales as alternate.

The principal speaker of the evening was A. C. Wallich, of Detroit, who gave a very interesting and instructive lecture on refrigerating machinery.

There was considerable discussion from the floor ranging from big air conditioning jobs to household air conditioning.

E. E. Dubry made the motion, which was carried, inviting the National Society to hold its summer meeting in Detroit or the vicinity of Detroit in 1933.

January 6, 1932—The Detroit Lubricator Co. invited the Chapter to hold its third technical meeting at its plant, to see a demonstration of testing thermostats and make a tour through the factory.

January 18, 1932—The Detroit Edison Co. was the host of the 90 members and guests of the Chapter.

C. H. Hirshfeld was introduced by J. H. Walker and gave an illustrated lecture on What Next?, which covered past and

future development of steam power plants. An entertainment program followed.

February 1, 1932—The fourth technical meeting was held February 1, 1932 at the Campbell Street Plant of the U. S. Radiator Corp., with 75 members and guests present. The meeting consisted of a trip through the plant to see the method of material control, core making, molding, machining and assembling of boilers and radiators. R. F. Connell introduced speakers from various departments, including Messrs. Dieder and Booth, who described the new concealed and mural type radiation.

February 15, 1932—About 50 members and guests were present for the meeting in the Detroit Engineering Society Building. Pres. Giguere introduced S. S. Sanford who presented a paper on Field Studies of Office Building Cooling, which discussed the air conditioning of the first sixteen floors and two basements of the Union Guardian Building. E. P. Wells of the Union Guardian Building gave a brief sketch of the building operation.

February 29, 1932—Monday evening found 70 members and guests of the Chapter assembled to partake of the hospitality of Messrs. Alex MacGregor, Vice-President; Harry Hooks, Secy. and Treas.; G. D. Colyer, Asst. Secy., and A. T. Hopkins, Heating Engineer, of the Wolverine Tube Company's plant on Central Ave. John L. Fuller arranged this delightful and enlightening trip so that we would find how copper tube radiation was constructed.

March 14, 1932—About 40 members and guests met at the Detroit Engineering Society to hear Thomas Chester discuss air conditioning. A motion was made and seconded to obtain further details regarding the Society rejoining the Associated Technical Societies. Mr. Boales was appointed to handle the arrangements for those attending the mid-summer meeting at Milwaukee in June.

April 14, 1932—About 30 members and guests were present at the dinner meeting held at the Detroit Engineering Society. J. F. McIntire reported that the Council of the Society had accepted the invitation of the Michigan Chapter to hold its 1933 summer meeting in Detroit.

A. V. Hutchinson, Secretary of the Society, outlined the plans for handling Society Meetings. The principal speaker of the evening was Prof. Rowley, President of the Society, who gave a very interesting lecture on Looking Forward in the Science of Heating and Ventilation.

May 10, 1932—After spending the afternoon at golf and baseball 65 members and guests gathered for dinner in the dining room of the Meadowbrook Golf and Country Club. After dinner President Giguere asked for roll call and the reading of the minutes of the last meeting, after which Tom Brown distributed the golf prizes.

E. H. Clark reported on the Chapter funds and Pres. Giguere appointed an auditing committee consisting of Messrs. Dubry, Kurtz and Harrigan. The meeting was addressed by W. Long on America's Future.

Western Michigan

The Speakers and Educational Committee of the Western Michigan Chapter has prepared a tentative program for the coming season with the following speakers listed: October 10, S. S. Sanford; November 14, A. J. Nesbitt; December 12, V. W. Cherven; January 9, 1933, B. F. Parks.

The following Officers and Committees are now serving the Chapter:

President—D. L. Taze
Vice-President—K. L. Ziesse
Secretary—P. O. Wierenga
Treasurer—S. H. Downs
Board of Governors—O. D. Marshall, C. H. Morton, C. Lammers.

SPEAKERS & EDUCATIONAL
W. W. Bradfield, *Chairman*
E. L. Jaynes
H. Christenson

RECEPTION
J. J. Troske, *Chairman*
Chas. H. Morton
J. S. Knee

SICK COMMITTEE
C. H. Alexander, *Chairman*

EMPLOYMENT REPRESENTATIVE
C. R. McConner

ENTERTAINMENT & PROGRAM
K. L. Ziesse, *Chairman*
J. F. Johnston, Jr.
C. Lammers

MEMBERSHIP & ATTENDANCE
J. H. Van Alsburg, *Chairman*
W. J. Temple
W. J. Carroll
H. F. Reid
V. W. Cherven

PUBLICITY
O. D. Marshall, *Chairman*
W. G. Schlichting
C. J. Walsh

The Western Michigan Chapter was organized November 10, 1931, with headquarters in Grand Rapids and the officers elected were: *President,* O. D. Marshall; *Vice-President,* D. L. Taze; *Secretary,* C. H. Alexander; *Treasurer,* K. L. Ziesse; *Board of Governors,* W. W. Bradfield, W. J. Carroll, E. L. Jaynes.

A preliminary meeting had been held October 8 with 30 men present, the guests of honor being W. H. Carrier, President of the Society; J. R. McColl, W. A. Rowe and J. F. McIntire of Detroit and A. V. Hutchinson, Secretary.

At the December 14 meeting, S. S. Sanford spoke on Modern Method of Saving Heat in Buildings. At the January meeting held on the 11th, E. N. McDonnell spoke on Design, Application and Operation of Boiler Feeders and E. H. Davis explained the Principles and Application of Piston and Centrifugal Boiler Feed Pumps.

In February the Chapter members heard an interesting talk on Crime and Methods of Combating It by Corp. Sullivan of the Michigan State Police and for the technical feature, a resumé of papers presented at the Society's Annual Meeting in Cleveland was given by Prof. L. G. Miller and Prof. H. P. Dirks.

John F. Hale told of his 40 years experience in the heating and ventilating industry at the March meeting.

At the April meeting on the 11th, Prof. F. B. Rowley, President of the Society, was the featured speaker and explained the results of some recent research work that he had done on thermal conductivity of various building materials. A. V. Hutchinson, Secretary of the Society, gave a summary of the activities and told something about the financial and membership problems.

The May meeting was the Chapter's spring frolic at which the officers now serving were elected.

Minnesota

Plans for the coming season for the Minnesota Chapter are reported by Secretary C. E. Lewis and the program opened on September 12 when the Chapter entertained Prof. G. L. Larson, Chairman of the Society's Committee on Research.

The October meeting is to be devoted to Weather Forecasting, the subject being given by the official weatherman of the City of Minneapolis.

No business is on the program for the November meeting as this will be the annual dinner-dance and party for members and ladies.

Gas Heating is to be the topic of discussion in December.

A brief review of the 1931-1932 season is given in the following paragraphs:

The first meeting of the season held on October 12, 1931, at the Men's Union Building, University of Minnesota, was devoted to Insulation Problems and after the disposal of the regular business, the following speakers were introduced: J. F. Bush discussed Insulation of Coolers; Messrs. Brown and Ferguson talked about Magnesia Pipe Covering, and V. Larsen gave some facts on Insulation Service.

In place of the regular November meeting, the Minnesota Chapter was host to 64 members, their wives and guests at a dinner-dance at the Thorpe Country Club. A delightful dinner was followed by dancing and cards.

The December 21 meeting was held at the Washburn High

School in Minneapolis and after the disposal of regular business, the meeting was turned over to A. L. Sanford, engineer for the Board of Education, who described briefly the mechanical features of both the Washburn and Ramsey Schools. Paul Smith gave a short talk on Welding, with reference to some of the welding features used in the Ramsey School. The subject of Ernest T. Bros was Stokers, and he outlined the development of stokers and compared operating costs of various fuels. On the same topic Harold S. Morton indicated the engineering data required and the method of selecting a stoker for the required load. Following the talks, an inspection was made of the boiler room which serves both schools.

The January 18 meeting was held at the Minnesota Union, University of Minnesota. The subject of the evening was New Developments in the Application of Copper Pipe and Fittings, and was presented by three guest speakers—namely, L. H. Hummell of the Standard Sanitary Manufacturing Co., who spoke on copper fittings; H. H. Taylor of the Mueller Co., who spoke on copper pipe and fittings; D. W. Hickey of the Healey Plumbing Co., who spoke on servicing and installation.

The February meeting was held in the Minnesota Union, University of Minnesota and Prof. Frank B. Rowley, the newly elected President of the Society, was the only guest and principal speaker of the evening. Prof. Rowley gave as his talk, Looking Forward in Heating and Ventilating, which was very interesting and greatly appreciated by the audience. Rudolph Lee, associate editor of the *Minneapolis Journal,* presented a very interesting view on Smoke Abatement.

The March meeting was held on the 14th, and Arthur Hardgrave, of Kansas City, Mo., presented a paper on the Use of Ice for Space Cooling. This talk created a great deal of interest.

The April 11 meeting was held at the St. Paul Municipal Auditorium, the mechanical equipment of which was designed by Carl E. Gausman and E. F. Jones, members of the Chapter. These men each gave very interesting talks on the special features of the mechanical equipment and following the discussion, an inspection trip was made through the Auditorium.

The May meeting of the Society was held on Monday, the 9th, at the Golden Valley Golf Club in Minneapolis, and after the afternoon golf tournament, dinner was served, followed by the Annual Election of Officers and Board of Governors.

Officers and Board of Governors

W. F. Uhl, *President*
A. B. Algren, *Vice-President*
C. E. Lewis, *Secretary-Treasurer*
H. E. Gerrish
C. E. Gausman

STANDING COMMITTEES 1932-1933

MEETINGS COMMITTEE
A. B. Algren, *Chairman*
N. D. Adams
A. L. Sanford

PUBLICITY COMMITTEE
M. H. Bjerken, *Chairman*
G. A. Dahlstrom
Fred Shernbeck

LEGISLATIVE COMMITTEE
S. A. Challman, *Chairman*
G. R. Magney
G. C. Morgan

NOMINATING COMMITTEE
H. E. Gerrish, *Chairman*
D. M. Forfar
E. F. Jones

AUDITING COMMITTEE
E. J. Burns, *Chairman*
L. H. Johnson
Robert M. Eiss

MEMBERSHIP COMMITTEE
Albert Buenger, *Chairman*

New Members—H. J. Sperzel, *Captain* New Members—A. J. Huch, *Captain*
Attendance—D. M. Forfar, *Captain* Attendance—E. F. Jones, *Captain*

N. D. Adams	E. Y. Arnold	P. E. Anderson	C. G. Burritt
A. B. Algren	M. H. Bjerken	A. W. Andresen	S. A. Challman
L. R. Amundson	H. H. Bradford	H. M. Betts	C. J. Dock
R. H. Anderegg	E. J. Burns	B. P. Bredesen	R. M. Eiss
A. D. Armstrong	T. T. Cash	J. H. Brown	C. D. Fitts
Wm. B. Clarkson	Wm. McNamara	C. E. Gausman	E. Nesdahl
G. A. Dahlstrom	M. W. Miller	H. E. Gerrish	R. W. Otto
R. W. DeLaney	R. B. Mosher	J. R. Hall	C. H. Pesterfield
Wm. A. Eckley	W. N. Parks	Leon C. Hanson	O. J. Pfeifer
Charles Foster	H. M. Porter	J. M. Heagler	A. H. Probst
H. L. Fritzberg	D. C. Ruff	H. C. Herrmann	F. B. Rowley
G. F. Girrbach	Fred Shernbeck	D. W. Hickey	A. L. Sanford
E. B. Gordon	Allen Spafford	C. E. Hill	C. J. Scanlan
L. C. Gross	W. Spofforth	L. H. Johnson	R. R. Schulte
H. R. Harris	A. E. Swanstrom	T. R. Johnson	A. Schwertfeger
J. B. Harris	R. N. Trane	C. E. Lewis	J. E. Swenson
H. G. Helstrom	M. A. Welter	H. H. Lowe	C. S. Ten Brook
P. C. Hitchcock	C. S. Whitnah	G. R. Magney	E. J. Uhl
L. L. Kuempel	A. V. Winterer	J. V. Martenis	W. F. Uhl
E. A. Lamb	G. G. Zingsheim	J. J. Mikesh	F. C. Winterer
E. B. Lewis		G. C. Morgan	M. S. Wunderlich
		H. S. Morton	

New York

The fall season for the New York Chapter will open October 17 with a presentation of The Engineering Problems of Radio City in Rockefeller Center by Mr. Williams of the office of Clyde R. Place, consulting engineer. A Symposium on Ventilation is scheduled for the November 21 meeting with W. H. Driscoll, A. J. Nesbitt and Prof. C-E. A. Winslow the featured speakers and a Program of Motion Pictures is planned for December 19. A Symposium on Refrigeration will be held January 16 and on February 20 the Theory of Self-contained Valves will be discussed.

The officers and committees now serving are:

President—L. T. M. Ralston
Vice-President—Harold Alt
Treasurer—W. M. Heebner
Secretary—T. W. Reynolds
Board of Governors—Russell Donnelly, L. K. Berman, R. Kuhlmann.

MEETINGS COMMITTEE
H. W. Fiedler, *Chairman*
S. A. S. Patorno
Elwood S. White

MEMBERSHIP COMMITTEE
W. W. Timmis, *Chairman*
V. J. Cucci
H. W. Hochuli
H. L. Hosking
M. E. Durkee

A synopsis of the meetings which were held from October 1931 to May 1932 is given in the report of Secretary T. W. Reynolds, who states that the average attendance for the year was 80 people at each meeting. He also gives the membership status of the Chapter on September 1, 1932, as 181 members.

October 19, 1931—A free-for-all discussion was the first number on the season's program of the New York Chapter. Messrs. R. H. Carpenter, W. H. Driscoll and Thornton Lewis spoke on miscellaneous matters of interest to the chapter membership such as Codes, the Research Policy of the Society, etc.

November 9, 1931—Joint meeting with the Power Division of the *A. S. M. E.;* New York Chapter of *American Institute of Architects; New York City Assn.* of *the Heating and Piping Contractors* and Management Division of the *Real Estate Board of New York.*

Subject: Influence of Corrosion in Heating Systems by R. E. Hall and A. R. Mumford. The authors told of their one year intensive study and investigation in New York buildings which tends to point out that the trouble lies mostly in operation rather than design or installation of a heating system.

December 21, 1931—Harold L. Alt gave an illustrated lecture on the Experiences of a Chapter Member in Soviet Russia and Turbulent China. The subject proved unusually interesting, the audience was attentive and stayed late.

January 18, 1932—Pierce Williams, Executive Director of the National Bureau of Economic Research spoke on the Engineers Opportunity for Public Service in the Present Business Crisis.

February 15, 1932—Col. W. E. Chevalier of the McGraw-Hill Co., known as a speaker of unusual force and charm, spoke upon the present financial situation and the trend of business for the coming year.

March 21, 1932—The President of the Society, Prof. F. B. Rowley of the University of Minnesota, was the speaker of the evening.

April 18, 1932—T. S. Tenney, Consulting Engineer, spoke on the system of Hot Water Convection Heating that serves the sixty-story Doherty Building.

May 9, 1932—The season activities were closed with the Annual Dinner and Entertainment with an attendance of 178.

Western New York

The Western New York Chapter will open its season October 10, according to the statement of Joe Davis, Chairman of the Program Committee. Treas. W. F. Johnson reports that black figures still appear in his records so that Pres. M. C. Beman looks forward to a most successful year.

The report of Secretary W. E. Voisinet gives a summary of the meetings held from October 1931 to June 1932.

October 12, 1931—The Fall Meetings were resumed enthusiastically and some 30 members were entertained by L. A. Harding whose subject, Utilization of the Sun's Energy was presented in an informal and interesting manner.

November 9, 1931—At a Dinner and Meeting held at the Hotel Buffalo, the Chapter was host to the Officers and Council of the Society. Pres. Joe Davis presided at this banner turnout which was attended by 117 members and guests. Pres. W. H. Carrier was the principal speaker and he gave a very interesting and well illustrated talk on Servicing the Human Power Plant. Later a general discussion was held regarding the efforts of the Society's Committee on Ventilation Standards to prepare a code for legislative purposes. The Committee was present at this meeting and the local Chapter benefited greatly by the remarks of the members.

December 14, 1931—On this date the Chapter held its Annual Xmas Stag Party at the University Club. Forty-five members engaged in this social gathering which was followed by a buffet lunch. At the short business session, Joe Davis was named as representative and D. J. Mahoney as alternate, to serve the Chapter on the Nominating Committee at the Annual Meeting.

January 11, 1932—Election of Officers was conducted at this meeting and an unanimous vote given the entire ticket.

President—M. C. Beman
Vice-President—D. J. Mahoney
2nd Vice-President—J. J. Yager
Treasurer—W. F. Johnson
Secretary—W. E. Voisinet

The speaker of the evening, H. M. Hammond of the Bailey Meter Co., gave a very interesting and instructive talk on the Use of Recording Instruments in the Boiler Room.

February 6, 1932—Following the precedent of former years, this meeting was in the form of a dinner dance and formal installation of Officers. It was very well attended and seemingly this social gathering was well worth while due to the creation of a closer and friendlier bond between the members.

March 14, 1932—Pres. Beman started out his regime with a well attended technical meeting, having for the speaker of the evening, A. G. Smith, Gen. Sales Mgr. of the Buffalo General Electric Co. Mr. Smith's discussion of the electrical development of the Niagara Frontier was well received and certainly was instructive to the members present.

April 14, 1932—At this meeting the Chapter acted as host to our National President, Prof. F. B. Rowley, and Secretary A. V. Hutchinson. Prof. Rowley addressed the members on Looking Forward in the Science of Heating and Ventilation. With the aid of slides Prof. Rowley very interestingly depicted the history of our industry from cave man days to present developments and presented also a picture of what to expect in the future. Our President gave tribute to the part played by the Research Department in this development. Prof. Rowley's talk and comments from our national secretary made this meeting one of the high lights of the year.

May 9, 1932—This meeting was a slight departure from the usual routine as the members met in the N. Y. Telephone Exchange, partaking of their cafeteria dinner, after which they were entertained by an interesting talk on how trans-atlantic calls were made. A. C. Coupe, of the Public Relations Dept., was in charge and afterwards the entire assemblage of 35 members was conducted in groups through the maze of mechanisms making up the automatic dial system.

June 22, 1932—The season closed with the Annual June Dinner Dance at the Auto Club in Clarence. This was whole-heartedly supported and the members and their wives thoroughly enjoyed this festive occasion.

Ontario

The Ontario Chapter at Toronto held six meetings between October 1931 and May 1932. In the annual report of Secretary H. R. Roth, he gives a review of the meetings as follows:

October 6, 1931—Bowling Contest.

November 13, 1931—Willis H. Carrier, President of the Society: Economic Aspect of Air Conditioning for Human Comfort.

December 10, 1931—T. McDonald: Automatic Control.

February 3, 1932—Prof. A. E. Allcut: Concealed Radiation.

April 14, 1932—Pres. F. B. Rowley: Looking Forward in the Science of Heating and Ventilation.

May 2, 1932—Installation of Officers and Social evening. The officers now serving are:

President—J. S. Wood
Vice-President—W. P. Boddington
Secretary-Treasurer—H. R. Roth
Board of Governors—M. W. Shears, J. S. Paterson, W. R. Blackhall, H. S. Moore.

Pacific Northwest

With W. E. Beggs as president, the Pacific Northwest Chapter of the Society had a successful year in 1931-1932. A variety of programs instructive and of great interest to the members was arranged by S. C. Heath, chairman of the Program Committee.

The first meeting of the season, held in October 1931, was well attended and a talk was given by Mr. Pollard of the Puget Sound Power and Light Co., on the steam heating plants and steam and water electric power generation plants of the company. At the same meeting Mr. Montgomery showed a picture illustrating the methods employed in the manufacture of wrought iron pipe.

The November meeting afforded the Chapter an opportunity of hearing S. C. Miller of the Elliott Co., whose talk on conditions governing the selection of prime movers was an insight into phases of engineering work the members do not ordinarily encounter.

The second November meeting was varied by the Chapter and guests' tour of the new Seattle Ford Plant under the guidance of Pres. W. E. Beggs.

At the February meeting H. A. McCune gave a talk on Acoustical Treatment of Buildings and Sound Absorption in Ventilating Equipment, and F. C. Green gave a talk on New Methods of Burning Cheap Grades of Coal.

On March 17 the speaker was Mr. DeForrest of Seattle, whose talk covered the field of building insulations and included something of the history and development of insulation materials. This talk was followed by another given by E. L. Weber, describing an equalizing non-reflex elbow which he had developed for use on hot water heating systems.

Again in April a Chapter member was the featured speaker; Ralph S. Whaley explained in detail, with diagrams, his new hot water heating system for motor buses which has been adopted by the Puget Sound Power and Light Co.

The final meeting of the year held in May was presided over by the newly elected president, C. H. Twist, who appointed his committees for the year 1932-1933. A talk on air filters was given by Mr. Dolbow.

The following officers for the 1932-1933 year have been selected:

President—C. F. Twist
Vice-President—P. M. O'Connell
Treasurer—W. W. Cox
Secretary—S. D. Peterson
Board of Governors—W. E. Beggs, E. O. Eastwood, E. L. Weber.
Program Committee—S. D. Peterson, *Chairman;* A. L. Pollard, W. E. Beggs.

The first meeting of the new season, Oct. 11, will have Pres. F. B. Rowley as the guest of honor.

Philadelphia

In his annual report, Secretary William P. Culbert outlines the following program for the coming season.

October—Convection Heaters.

November—Inspection of heating and ventilating installation in Penn Mutual Life Insurance Co. Building.

The list of subjects and speakers for 1931 meetings were:

October—*Speaker,* John L. Grimes of the Wheeling Steel Corp.
Subject—Motion pictures of Steel Making from Mine to Market.
Speakers, Benjamin Adams and L. C. Davidson, both Chapter members.
Subject—Fans and their proper application to ventilating systems.

November—Papers on Better Cooperation between Architect, Engineers and Contractors, presented by Chapter Members engaged in these professions.

December—*Speaker,* Pres. Willis H. Carrier.
Subject—Servicing the Human Power Plant (illustrated by lantern slides).

January—Annual Meeting and Banquet, held at the Arcadia Cafe. Evening of entertainment.

February—*Speaker,* S. K. Wolfe of the Electric Research Products, Inc.
Subject—Noise, Its Measurement and Abatement (illustrated by lantern slides).

March—*Speaker,* George S. Bliss, Philadelphia Weather Bureau Dept.
Subject—Weather Bureau Operations and Information.

April—*Speaker,* George Bach of the Union Iron Works.
Subject—Design of Power Boilers and Application to Heating Systems (illustrated by lantern slides). A motion picture on the manufacture of fire brick and refractories.

May—Regular Spring outing at Llanerch Country Club, Llanerch, Pa. Sports, and entertainment in the evening.

The Chapter membership totals 171 and the Officers and Committees are as follows:

Officers and Board of Governors:
President—L. C. Davidson
Vice-President—M. F. Blankin
Secretary—W. P. Culbert
Treasurer—J. H. Hucker
Board of Governors—E. N. Sanbern, H. F. Rettew, W. R. Eichberg.

MEETINGS COMMITTEE
W. R. Eichberg, *Chairman*
A. C. Caldwell
A. A. Miller
Morris Sheffler
W. F. Smith
C. S. Wilmot

MEMBERSHIP COMMITTEE
H. F. Rettew, *Chairman*
H. G. Black
J. D. Cassell
Lee Nusbaum
F. C. Hibbs
Karl Rugart
C. B. Eastman

COMMITTEE ON PUBLICITY
(Meetings Sub-Committee)
J. A. Carey, *Chairman*
H. H. Mather

COMMITTEE ON ATTENDANCE
(Membership Sub-Committee)
H. M. Patrick, *Chairman*
R. F. Hunger
W. A. Bornemann

YEAR BOOK COMMITTEE
H. H. Erickson, *Chairman*
H. J. Walther

FINANCE COMMITTEE
A. McClintock, Jr., *Chairman*
J. H. Hucker
R. P. Schoenijahn

LEGISLATIVE COMMITTEE
J. D. Cassell, *Chairman* (one year)
R. C. Bolsinger (two years)
F. D. Mensing (three years)

NOMINATING COMMITTEE
E. N. Sanbern, *Chairman*
J. D. Cassell
H. P. Gant
W. F. Smith
A. A. Miller

Pittsburgh

Eight meetings of the Pittsburgh Chapter were held during the past year and a summary of the meetings is given in the report of the Secretary, J. L. Blackshaw.

At the first meeting of the members of the Pittsburgh Chapter of the Society for the year 1931-1932, held in the Keystone Athletic Club, Pittsburgh, on Monday, October 5, 1931, Willis H. Carrier, president of the Society, delivered a most interesting and instructive illustrated talk on Servicing the Human Power Plant, and C. W. Farrar, chairman of the Committee on Increase of Membership, gave an enlightening discussion on membership in the Society.

On November 9, 1931, a meeting was held in McCann's Dining Rooms at which Dwight L. McNulty, mechanical engineer for the Byllesby Engineering and Management Corp., presented a discussion of The Design and Construction of Underground Steam Lines.

At the annual meeting of the Chapter, held in McCann's Dining Rooms on December 7, 1931, the following officers were elected to hold office during the year 1932:

President—R. B. Stanger
Vice-President—F. C. McIntosh
Secretary—J. L. Blackshaw
Treasurer—H. B. Orr
Board of Governors—F. C. Houghten, G. S. McEllroy, H. Lee Moore.

Following the election, the meeting was addressed by John R. Hertzler of New York, manager of the air conditioning department of the York Ice Machinery Corp., who spoke on Refrigeration as Applied to Air Conditioning, illustrating his address with slides.

The January 11 meeting was an informal get-together at McCann's Dining Rooms, where each member smoked either a corncob pipe or a Pittsburgh stogie while he discussed the "situation" and watched several reels of motion pictures bearing on the heating and ventilating industry.

At the meeting held in Hotel Mayfair on February 15, 1932, Dr. HuBert C. Eicher, Director of the School Building Division of the Pennsylvania Department of Public Instruction, spoke on Some Local and State Problems in Heating and Ventilating School Buildings.

W. H. Driscoll, vice president of Thompson-Starrett Co., a former president of the Society, talked on the development and accomplishments of heating and ventilation at the March meeting, which was held at the Mayfair Hotel on March 17, 1932.

At a meeting held at the Fort Pitt Hotel on April 15, 1932, A. V. Hutchinson, secretary of the Society, outlined its activities, and Professor F. B. Rowley, of the University of Minnesota, president of the Society, gave an interesting address on Looking Forward in the Science of Heating and Ventilation.

H. B. Meller, Chief of the Bureau of Smoke Regulation for Pittsburgh, talked on The Control of Air Pollution at the meeting held in the Fort Pitt Hotel on May 23, 1932. This was the final meeting of the season marked, throughout its length, by a noteworthy increase in attendance partly due, it is believed, to the practice of prefacing each meeting with a dinner at which an atmosphere of good fellowship is established.

St. Louis

The St. Louis Chapter made an early start in September with Prof. G. L. Larson, Chairman of the Committee on Research as the featured speaker, his subject being Something New in Heating and Ventilating. The plans for the October meeting outlined

by Secy. C. R. Davis provide for sessions at the University of Illinois in Urbana, four Chapters combining to make this a gala occasion. The Chapters participating are St. Louis, Kansas City, Illinois and Wisconsin. The Officers and Committees now serving are:

President—J. M. Foster

Vice-President—C. L. Pickett, P. Sodemann

Secretary—C. R. Davis

Treasurer—A. L. Walters

Board of Governors—E. A. White, George Myers, R. M. Rosebrough, L. Walter Moon.

COMMITTEES

Program Committee—Paul W. Sodemann, *Chairman;* L. Walter Moon, John W. Cooper.

Entertainment Committee—C. A. Pickett, *Chairman;* Louis Steckhan, E. E. Carlson, James King Kent, Ralph H. Metcalf.

Membership Committee—G. A. Helwig, Geo. Myers, E. R. Barnes, Fred G. Axthelm, O. H. Wolff, Kenneth S. Wallace, E. B. Evleth.

Publicity Committee—Geo. Myers, *Chairman;* G. A. Helwig, C. R. Davis.

Resolutions Committee—Wm. C. Sodemann, R. M. Rosebrough, F. J. McMorran.

Educational Committee—Sam G. Hallett, *Chairman;* John J. Griffin, A. L. Walters, W. H. Niestrath, H. A. Grossmann.

Research Committee—E. B. Langenberg, *Chairman;* Wm. T. Thomsen, F. C. Picker, R. J. Smith.

Auditing Committee—L. Walter Moon, *Chairman;* F. J. McMorran, Paul W. Sodemann.

Employment Officer—E. A. White.

Ass. Eng. Soc. Committee—J. M. Foster, *Chairman;* E. A. White, Counsellor; E. B. Langenberg, Alternate.

Ten meetings were held by St. Louis Chapter during the 1931-1932 season, the program beginning in September with the annual outing, golf tournament, bridge party and dinner-dance at the North Shore Country Club.

In October, W. H. Carrier, President of the Society, talked on the subject Servicing the Human Power Plant.

At the November meeting, E. F. Edwards spoke on the Application of Refrigeration in Air Conditioning and Comfort Cooling. The December meeting was made notable by the election of officers now serving the Chapter. Two papers were presented at the January meeting, one by E. H. Beling on the New Science of Ventilation, the other by Archie Gordon on Acoustics in Heating and Ventilating. The Use of Ice for Comfort Cooling was explained by Arthur Hardgrave of Kansas City, at the February meeting and in March, the Chapter enjoyed a visit by the President and Secretary of the Society, Prof. F. B. Rowley and A. V. Hutchinson. An added feature was a talk by Roscoe Nunn of the St. Louis Weather Bureau.

A joint meeting was held with the Kansas City Chapter in Kansas City during April and Prof. A. C. Willard, University of Illinois, spoke on Research and Engineering.

In May, Dean A. S. Langsdorf of Washington University, talked about Dust Counting. The annual summer party was held in June at North Hills Country Club and there was a golf tournament, bridge party and dinner dance on the program.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate or membership by letter ballot. During the past month 3 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some members by October 15, 1932, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES

CHARLTON, JOHN FELDER, Valuation Engr., Ft. Lauderdale, Fla.

MOORE, TEDD R., New York Plumbing Specialty Co., New York, N. Y.

RINEHART, WILSON R., Engr., W. F. Hirschman Co., Le Roy, N. Y.

REFERENCES

Proposers	*Seconders*
G. W. Sackett—*A.S.C.E.*	L. L. Mills—*A.S.C.E.*
B. P. McWhorter—*A.S.C.E.*	Theo. Goshen—*A.S.C.E.*
L. T. M. Ralston	Russell Donnelly
S. G. Pizie	W. E. Heibel
T. W. Reynolds	
W. F. Hirschman	W. A. Bornemann
Joseph Davis	C. E. Scott

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

AXEMAN, JAMES E., Br. Mgr., Spencer Heater Co., Baltimore, Md. (*Advancement*)

HARRINGTON, ELLIOTT D., Mgr., Com. Engrg. Div., Air Cond. Dept., General Electric Co., Schenectady, N. Y. (*Advancement*)

PECK, ROBERT E., Vice-Pres., Peck, Hannaford & Peck Co., Cincinnati, O.

SIGMUND, RALPH W., Dist. Mgr., B. F. Sturtevant Co., Cincinnati, Ohio.

TUVE, GEORGE L., Assoc. Prof. of Mech. Engrg., Case School of Applied Science, Cleveland, Ohio.

WECHSBERG, OTTO, Pres. and Gen. Mgr., Coppus Engineering Corp., Worcester, Mass.

JUNIOR

WINTHER, ANKER, Air Cond. Engr., York Ice Machinery Corp., Cincinnati, Ohio.

STUDENT

HESS, DAVID K., Student, University of Wisconsin, Madison, Wis.

The EDITOR'S PAGE

Heating · Piping *and* Air Conditioning

AIR conditioning is a subject that should be studied carefully by the management of the plant or building intent on improving operation and getting in shape for the keen competition which exists now and which is indicated for the future. Plenty of industrial and commercial enterprises are making money at today's reduced volume of business; they are the ones that have studied their processes and their operation and have put their equipment in shape to carry on economically and efficiently. With increased business activity, such concerns will be in a particularly advantageous position insofar as competition from not-so-completely equipped competitors is concerned.

WHAT air conditioning can do in improving a process or in putting a building in shape to earn better rentals is demonstrated emphatically by the experiences of several concerns described in a special report just issued by the general section of the *National Electric Light Association;* this report surveys opportunities for selling power for air conditioning in industrial buildings, theaters, office buildings, hotels, restaurants, stores, public buildings, etc. An investment of $61,000 for air conditioning a cotton and silk products mill saves over $14,000 annually, says this report. A cigarette manufacturer increased the output of his automatic packing, wrapping and sealing equipment by providing correct atmospheric conditions, resulting in a 400-per cent increase in production. Spending $34,000 for air-conditioning equipment, a cigar manufacturer gets a $29,000 return each year.

.....a manufacturer of effervescent salts saves $25,000 year by an investment of $36,000 in air conditioning.

.....a rayon plant's production was increased 27 per cent with air conditioning.

.....air conditioning enabled one department of an industrial chemicals plant to run throughout the year, instead of for only 200 days with consequent loss due to unproductive overhead charges.

AIR conditioning in theaters is regarded as standard and has eliminated the summer slump in this business. Restaurants find many advantages in air conditioning; patronage is increased, as is the average price of the meals served. One restaurant (see page 734 of this issue) enjoyed a 60-per cent increase in business the first summer after it installed a cooling system. A number of department stores have found air conditioning increased their sales and gave other advantages; air-conditioned office buildings have been able to get and hold tenants because of air conditioning; banks, hotels, public buildings, etc. have found air conditioning to be a paying proposition.

IN checking an existing installation of air-conditioning equipment to be sure that it is in order for efficient and economical operation, the chart and maintenance guide on page 737 of this issue will be found useful. A number of articles which have appeared from time to time in HEATING, PIPING AND AIR CONDITIONING will also be found of aid in this connection; some of them are:

"The Maintenance of Air Conditioning Equipment in Industrial Plants," by William A. Hanley, page 905, November, 1930. Vol. II, No. 11.

"Now Is the Time to Overhaul Air Cooling and Refrigerating Equipment," by R. C. Doremus, January, 1931, page 1. Vol. III, No. 1.

"Improved Compressor Operation a Road to Air Conditioning Economy," by John C. Reed and Edgar E. Ambrosius, page 746, September, 1931. Vol. III, No. 9.

"45 Per Cent Power Saving Made by Intermittent Control of Central Station Type Air-Conditioning System," by Charles S. Leopold, page 989, December, 1931. Vol. III, No. 12.

"Chart Helps Duct Changes," by George T. Condron, page 555, August, 1932. Vol. IV, No. 8.

"Economy in Drying Aided by Vapor Proofing," by Malcolm Tomlinson, page 482, July, 1932. Vol. III, No. 7.

"Turning Blades Reduce Duct Elbow Losses," by F. E. Wertheim, page 915, November, 1931. Vol. III, No. 11. Discussion, page 84, January, 1932.

"Saving Money in Motor Operation," by Louis Mackler, page 649, August, 1931. Vol. III, No. 8.

"Operation and Maintenance of Air Filters," by W. G. Frank, page 378, May, 1931. Vol. III, No. 5.

"How to Install and Care for Gages," by John A. Masek, page 727, September, 1931. Vol. III, No. 9.

MANY of the articles in this issue point the way to saving money, improving operation. The Belle City Malleable Iron Co. (page 728) uses waste-heat boilers for supplying steam used for compressing air and space heating; Herman Vetter (page 731) shows how power may be saved by proper sizing of ammonia suction lines; L. K. Ferris points out how he saves on heating water for use in the building in his charge (page 721); several articles in "On the Job" (page 742) describe practical points of help in maintenance work.